COPY FOR MR. J. ALLAN ROSS





HYDRO-ELECTRIC INQUIRY COMMISSION

# ENGINEERING DATA

## ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

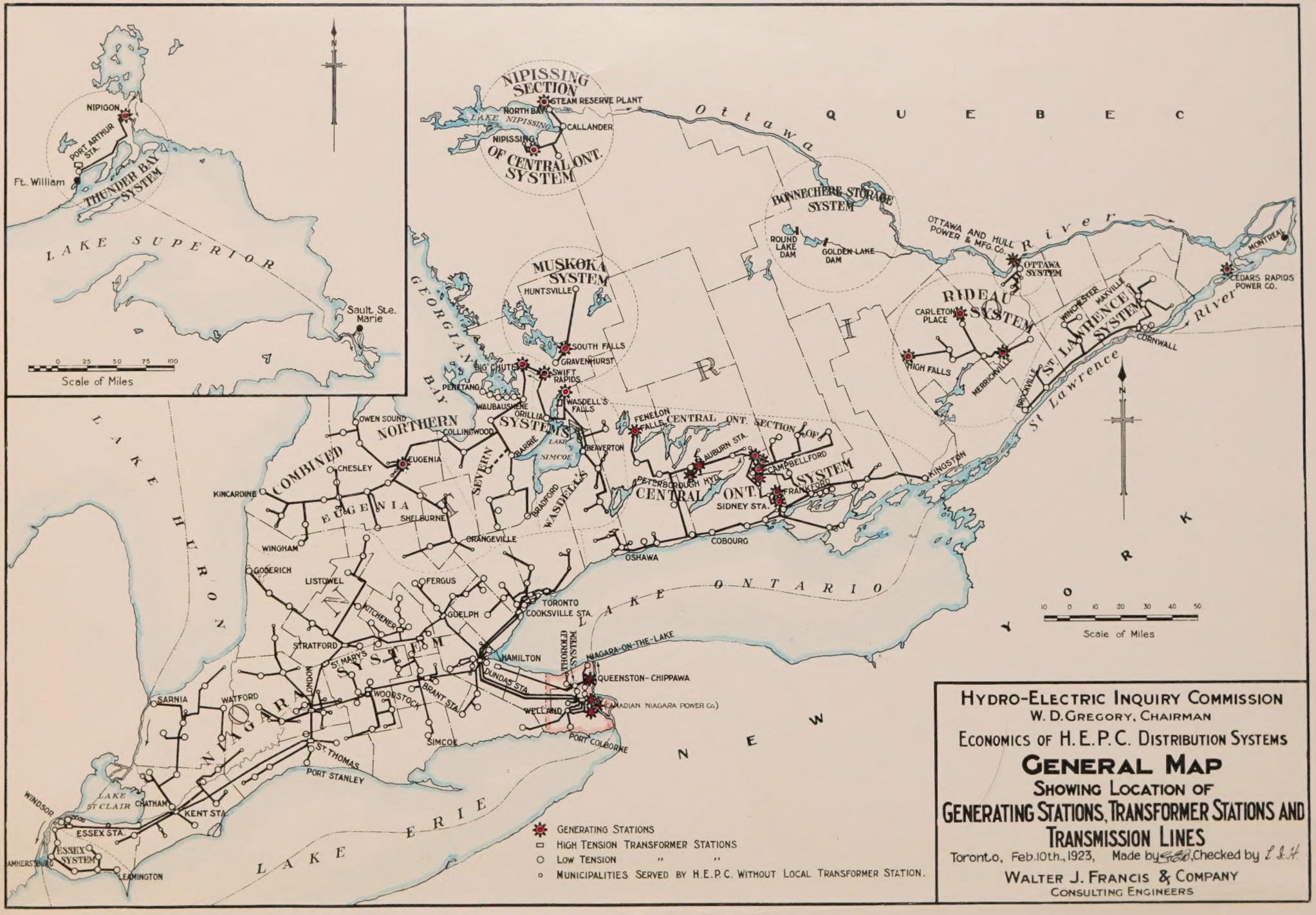
## STUDY OF THE SYSTEM
## OF
## THE ONTARIO POWER COMPANY OF NIAGARA FALLS

WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS

# THE SYSTEM OF

# THE ONTARIO POWER COMPANY OF NIAGARA FALLS


HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
GENERAL MAP
SHOWING LOCATION OF
GENERATING STATIONS, TRANSFORMER STATIONS AND TRANSMISSION LINES
Toronto, Feb. 10th., 1923, Made by G.S.B. Checked by L.S.H.
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS
GENERATING STATIONS
HIGH TENSION TRANSFORMER STATIONS
LOW TENSION " "
MUNICIPALITIES SERVED BY H.E.P.C. WITHOUT LOCAL TRANSFORMER STATION.
Scale of Miles
LAKE SUPERIOR
THUNDER BAY SYSTEM
NIPIGON
PORT ARTHUR STA.
Ft. William
Sault Ste. Marie
NIPISSING SECTION OF CENTRAL ONT. SYSTEM
STEAM RESERVE PLANT
NORTH BAY
LAKE NIPISSING
CALLANDER
NIPISSING
MUSKOKA SYSTEM
HUNTSVILLE
SOUTH FALLS
GRAVENHURST
BIG CHUTE
SWIFT RAPIDS
WASDELL'S FALLS
PERETANG
WAUBAUSHENE
ORILLIA
LAKE SIMCOE
BEAVERTON
GEORGIAN BAY
BONNECHERE STORAGE SYSTEM
ROUND LAKE DAM
GOLDEN LAKE DAM
OTTAWA AND HULL POWER & MFG. Co.
OTTAWA SYSTEM
Ottawa River
QUEBEC
MONTREAL
CEDARS RAPIDS POWER CO.
RIDEAU SYSTEM
CARLETON PLACE
HIGH FALLS
MERRICKVILLE
BROCKVILLE
WINCHESTER
MAXVILLE
ST. LAWRENCE SYSTEM
CORNWALL
St. Lawrence River
FENELON FALLS
CENTRAL ONT. SECTION OF
AUBURN STA.
CAMPBELLFORD
FRANKFORD
SIDNEY STA.
PETERBOROUGH HYD.
CENTRAL ONT. SYSTEM
KINGSTON
COBOURG
OSHAWA
LAKE ONTARIO
NEW YORK
LAKE HURON
OWEN SOUND
NORTHERN
COLLINGWOOD
COMBINED
EUGENIA
CHESLEY
KINCARDINE
SHELBURNE
SEVERN
BARRIE
BRADFORD
WASDELL'S
ORANGEVILLE
WINGHAM
GODERICH
LISTOWEL
FERGUS
GUELPH
KITCHENER
STRATFORD
TORONTO
COOKSVILLE STA.
THOROLD SYSTEM
HAMILTON
DUNDAS STA.
NIAGARA-ON-THE-LAKE
QUEENSTON-CHIPPAWA
(CANADIAN NIAGARA POWER Co.)
WELLAND
PORT COLBORNE
NIAGARA SYSTEM
ST. MARYS
LONDON
WOODSTOCK
BRANT STA.
SIMCOE
ST. THOMAS
PORT STANLEY
SARNIA
WATFORD
LAKE ST. CLAIR
CHATHAM
KENT STA.
WINDSOR
ESSEX STA.
ESSEX SYSTEM
AMHERSTBURG
LEAMINGTON
LAKE ERIE

To face frontispiece.

General Map Showing Location of

Generating Stations, Transformer Stations and Transmission Lines

of the

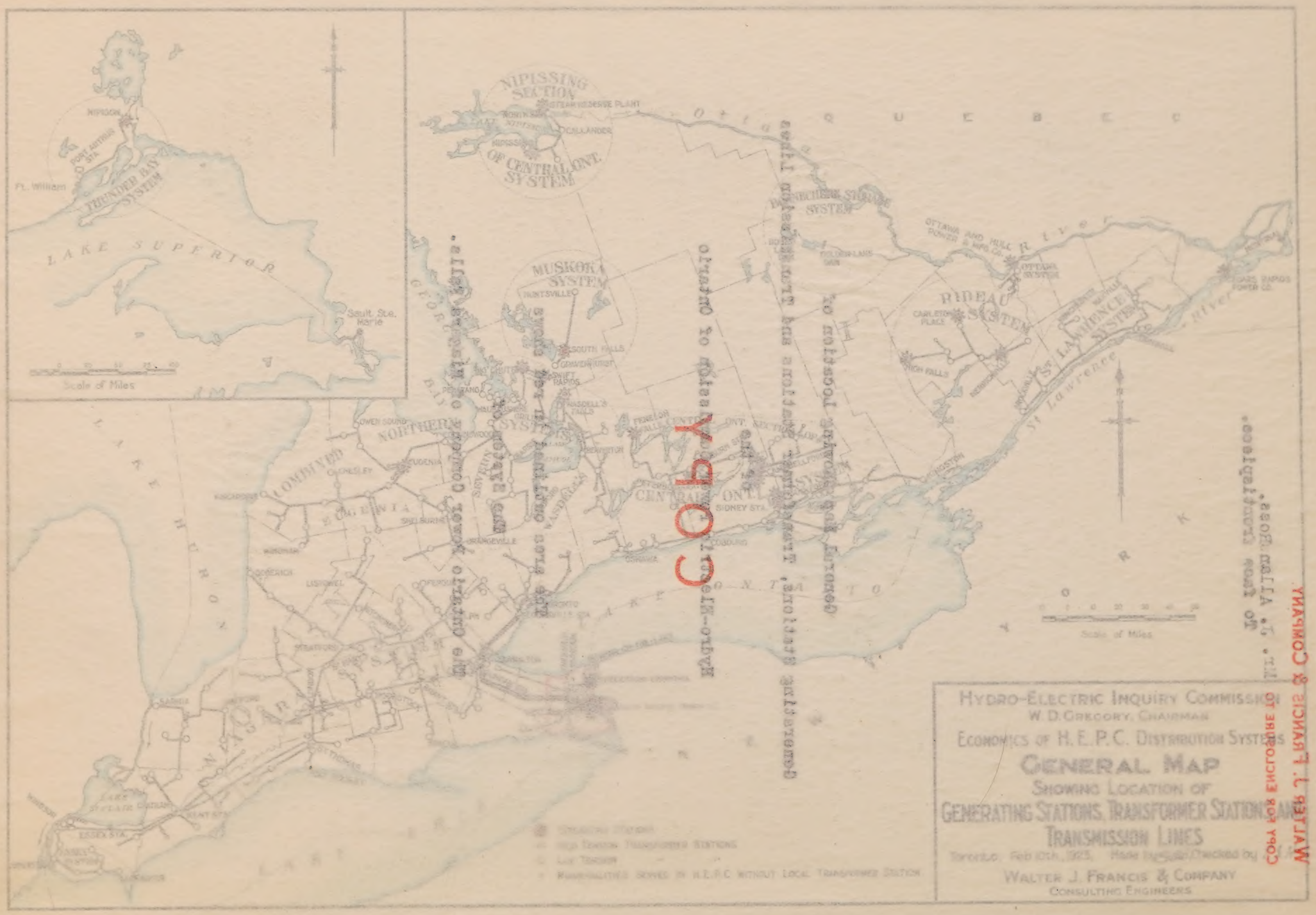
Hydro-Electric Power Commission of Ontario



The area outlined in red shows

The System of

The Ontario Power Company of Niagara Falls.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OTTAWA SYSTEM
CENTRAL ONT.
SIDNEY STA.
NORTHERN
COMBINED
LAKE ONTARIO
LAKE ERIE
LAKE HURON
LAKE MICHIGAN
Hydro-Electric Commission of Ontario
Ontario Power Generating Stations and Transmission Lines
Generating Stations
High Tension Transformer Stations
Low Tension " "
Municipalities served in H.E.P.C. without local transformer station
To Niagara Falls, N.Y., Buffalo, Lockport, Rochester, Syracuse, Utica, Albany, Montreal, Ottawa, Quebec, Toronto, Hamilton, London, Windsor, Detroit, Chicago, Milwaukee, Duluth.
COPY FOR ENGRS. OF THE
WALTER J. FRANCIS & COMPANY
COPY

# INDEX TO THE SYSTEM OF THE ONTARIO POWER COMPANY OF NIAGARA FALLS

(Illus.)

## LIST OF ILLUSTRATIONS

## THE SYSTEM OF THE ONTARIO POWER COMPANY OF NIAGARA FALLS

Toronto, Ontario,

June 7th, 1923.

Hydro-Electric Inquiry Commission,
W. D. Gregory, Esq., Chairman,
T O R O N T O, Ontario.

re Studies of Engineering Economics of the System of The Ontario Power Company of Niagara Falls of the Hydro-Electric Power Commission of Ontario.

Mr. Chairman and Gentlemen,-

In accordance with the letter to your Commission under date of November 4th, 1922, and your confirmation of the general instructions under date of November 15th, 1922, a study has been made of the engineering economics of the System of The Ontario Power Company of Niagara Falls of electrical generation and distribution operated by the Hydro-Electric Power Commission of Ontario. The work has been done under the direct personal supervision of Mr. Frederick B. Brown, M. Sc., M.E.I.C., a partner in the firm of Walter J. Francis & Company, in accordance with your instructions.



The subject has been discussed with Mr. Commissioner R. A. Ross in detail, and, generally, with Mr. Bower, the Secretary of your Commission, and constant communication has been maintained with the officials of the Hydro-Electric Power Commission of Ontario.

The reports of Messrs. Price, Waterhouse & Co. have been used as the basis of the financial figures given herein, and reference has been made to the records of the Hydro-Electric Power Commission of Ontario where it was necessary to do so to prepare the diagrams.

It is understood that it is not within the scope of the instructions to examine into any of the legal aspects of the System, nor discuss any of the Acts of the Legislature relating to it.

The necessary technical data has required considerable preparation, as much of it is only available in the operating records of the Hydro-Electric Power Commission of Ontario. The printed reports contain a part, but these have had to be supplemented by interviews with various officials, and by searching the voluminous records both at the head office in Toronto and elsewhere.

The general plan under which the report of the studies is presented may be outlined as follows:



(1) A short review of the history and evolution of the System.

(2) A brief physical description of the System.

(3) A brief discussion regarding the characteristics of the local market.

(4) A discussion of progressive capital costs.

(5) Statistics regarding progressive revenues for various classes of service, with discussion thereon.

(6) Statistics regarding progressive operating costs and fixed charges, with discussion thereon.

(7) Statistics regarding reserve accounts, with discussion thereon.

(8) Statistics showing progressive and accumulated deficits or surpluses, with discussion thereon.

(9) Analysis of progressive operating records and of unit revenues per kilowatt-hour and per horse-power per annum and of unit costs per kilowatt-hour and per horse-power per annum.

(10) A brief discussion of the various important points concerning the System.

The report included herewith as pages 4 to 76 inclusive refers in detail to that portion of the activities of the Hydro-Electric Power Commission known as the System of The Ontario Power Company of Niagara Falls.

Throughout the report diagrams have been included in the order of the text while the map included as a frontispiece shows the System generally and its geographical relation to all the other Systems operated by the Hydro-Electric Power Commission of Ontario.

## THE ONTARIO POWER COMPANY OF NIAGARA FALLS

Frederick B. Brown, M.Sc.

### Evolution and Development of the System.

The Ontario Power Company of Niagara Falls was originally incorporated, with an authorized capital of $250,000, by a special Act of the Dominion of Canada dated June 23rd, 1887, under the name of the Canadian Power Company. The Company was authorized to assume its present name, The Ontario Power Company of Niagara Falls, by an Act dated July 19th, 1899, and the presently authorized capital stock is $15,000,000 in accordance with permission granted at various times under powers conferred by the Act of Incorporation. The issued capital amounts to $10,000,000 face value.



An agreement known as the "First Agreement", with the Queen Victoria Niagara Falls Park Commission was made in 1900, by which the Company was given permission to conduct water in an open channel from the Welland River to a power house in the Park. Later the Company in addition to the rights for conducting water from the Welland River, applied for rights to divert water from the Niagara River. Following this application, on June 28th, 1902, an agreement known either as the "Second Agreement" or the "Complementary Agreement" was made with the Park Commission. By this agreement the rights of location and construction granted by the agreement of 1900 were surrendered and provision was made to conduct water from the Welland and Niagara Rivers by means of parallel lines of underground pipes or conduits. The Order-in-Council of October 7th, 1902, by which the Lieutenant-Governor approved this Second

## [illegible]

[illegible]

### [illegible]

The Shasta Power Company of Niagara Falls was originally incorporated, with an authorized capital of $[illegible], by a special act of the Legislature of [illegible] [illegible], under the name of the Evanston Power Company. The company was reorganized by [illegible] the present name. The Shasta Power Company of Niagara Falls, by an act passed July [illegible], 1887, and the [illegible] [illegible] [illegible]

Agreement, contains the important proviso that the approval is given provided that the works, plans, profiles and elevations are to be submitted for the approval of the Queen Victoria Niagara Falls Park Commissioners, and shall before such approval is given be approved by the Lieutenant-Governor in Council.

In accordance with this provision, a map, dated December 10th, 1902, was submitted showing the proposed works of the Company at Dufferin Island and the line of three pipes. Each of these pipes was 18 feet in internal diameter.

The amount of power which the Company is permitted to generate is not specified in the agreement, but as mentioned in the evidence of Mr. W. W. Pope at the hearing on December 21, 1922, it is stated in the reports of the Queen Victoria Niagara Falls Park Commission that the amount of water to be diverted for the Niagara River intake is that required to generate 180,000 horse-power. This was computed by the International Waterways Commission to be about 12,000 cubic feet per second. The Order-in-Council of the Ontario Government of June 18th, 1914, allowed the Company 11,180 cubic feet per second. The third pipe line, completed in 1919, was estimated to require an additional diversion of about 2,100 cubic feet per second and it was reported in Mr. Pope's evidence that the amount of water being diverted in 1920 by the Ontario Power Company was about 13,300 cubic feet per second.



Terms of License and Water Rentals.

The license was granted to the Ontario Power Company for a term of 50 years commencing April 1st, 1900. The Company has the option of three renewal periods of 20 years each, making the total period under the option 110 years. The

Lieutenant-Governor in Council may, after giving specified notice, require the Company to continue its operations for a further period of 20 years, thus making in all 130 years. Provision is made for the adjustment of rentals at each renewal period.

In consideration of such license the Company undertook to pay a yearly rental of $15,000, and in addition thereto, annual payments as follows:

$1.00 for each electrical horse-power generated and disposed of over 10,000 horse-power up to 20,000 horse-power.
.75 for each electrical horse-power generated and disposed of over 20,000 horse-power up to 30,000 horse-power.
.50 for each electrical horse-power generated and disposed of over 30,000 horse-power.

COPY

Contract for Power Sold to the Hydro-Electric Power Commission of Ontario.

When The Hydro-Electric Power Commission of Ontario in 1906 asked the electric power companies at Niagara Falls to submit a price on 100,000 electrical horse-power to be delivered to the Commission, the lowest tender received was that of the Ontario Power Company. A contract was entered into between the Commission and the Company on March 19th, 1908, for a maximum of 100,000 horse-power to be taken in certain blocks as required. This contract fixed the rate for power delivered at 12,000 volts, at $9.40 per horse-power per annum up to 25,000 horse-power, and at $9.00 per horse-power per annum for all the power when the amount reserved and held ready for delivery upon the order of the Commission totalled 25,000 horse-power or more. An additional charge of $1.00 per horse-power for power delivered at 60,000 volts was agreed upon. The duration of the contract corresponded with the water lease of the Company from the

Queen Victoria Niagara Falls Park Commission. The details of this contract are given on page 5 of Exhibit VII of the report of Messrs. Price, Waterhouse & Co. dated October 9th, 1922.

On March 25th, 1916, the amount of power ordered to be held in reserve for the Commission reached the total of the 100,000 horse-power available under this contract.

Purchase of the Ontario Power Company.

Prior to the year 1917, the Ontario Power Company asked permission of the Queen Victoria Niagara Falls Park Commissioners to construct a third conduit in accordance with their agreement in 1902, but the request was refused. At this time The Hydro-Electric Power Commission of Ontario began negotiations for the purchase of the Company and on April 12th, 1917, entered into an agreement for the purchase of the outstanding capital stock of the Company.



The purchase was consummated as of August 1st, 1917, J. J. Albright, Esq., of Buffalo, N. Y., acting as vendor on behalf of himself and the other stockholders of the Ontario Power Company. The purchase price was $80.00 per share of the issued capital stock of the Company, payable in 40-year four per cent. debentures issued by the Hydro-Electric Power Commission and guaranteed by the Province. The issued stock of the Company totalled $10,000,000, and since the date of purchase the Commission has acquired this entire amount and has issued in payment therefor debentures amounting to the face value of $8,000,000. The purchase included the issued stock of The Ontario Transmission Company, Limited, which amounted to $1,000,000 and which was owned by the Ontario Power Company.

Under the terms of the purchase agreement the Commission and the Province assumed outstanding mortgage bonds of the Ontario Power Company and of the Ontario Transmission Company to the amount of $14,450,000. In addition to the sum of $8,000,000 referred to above, the Commission in 1921 issued $3,200,000 of six per cent. 20-year bonds, guaranteed by the Province of Ontario, and with the proceeds retired $2,755,000 of six per cent. second mortgage bonds of the Ontario Power Company.

The properties of the Company are situated, for the most part, at Niagara Falls, Ontario, and, at the date of purchase, consisted principally of a hydro-electric generating plant, comprising a power house, two conduits or pipe lines, with the necessary headworks, and fourteen turbines and generating units and other equipment providing a capacity for generating approximately 160,000 horse-power. The Company also owned real estate as well as the transformer station, transmission lines and distributing stations required for its uses. The transmission and distributing system was under the control of The Ontario Transmission Company, Limited, the subsidiary company of the Ontario Power Company already mentioned.



The Ontario Transmission Company, Limited.

The Ontario Transmission Company, Limited, was incorporated by Letters Patent on July 14th, 1905, under the laws of the Dominion of Canada with an authorized capital of $1,000,000. The entire amount of the capital stock was issued and is owned by The Ontario Power Company of Niagara Falls, and has been endorsed over and deposited with The Toronto General Trusts Corporation as

collateral security to a Mortgage Deed of Trust, dated February 2nd, 1903, in favour of that Corporation, securing the Five Per Cent. First Mortgage Sinking Fund Gold Bonds of the Power Company.

The Company owns and operates transmission lines and distributing stations in the Niagara Peninsula. The properties are under lease to The Ontario Power Company of Niagara Falls, and are used by that Company in the transmission of power to its consumers.

A general plan of the distribution system of The Ontario Transmission Company, Limited, is shown on page 10 hereof.

At the date of purchase of the Ontario Power Company the Hydro-Electric Power Commission also accepted (a), all obligations and liabilities of the Power Company and the Transmission Company under all power supply contracts made with the following:



Niagara, Lockport and Ontario Power Company,
Canadian Steel Foundries, Limited,
Canada Cement Company, Limited,
Canadian Ramapo Iron Works,
Electro-Metals, Limited,
Department of Railways and Canals,
Coniagas Reduction Company,
American Cyanamid Company,
Town of Merritton,
Hydro-Electric Power Commission,
The Norton Company,
Dain Manufacturing Company, Limited,
Cronmiller and White Brewing Company,
C. Reichman & Sons,
James Battle,
Page, Hersey Iron Tube & Lead Company,
The Robinson Brothers Cork Company, Limited,
Ontario Paper Company, Limited,
A. E. Augustine,
Beaver Wood Fibre Company, Limited, (now Beaver Board Company, Limited)
Corporation of Port Colborne,
Humberstone Village,

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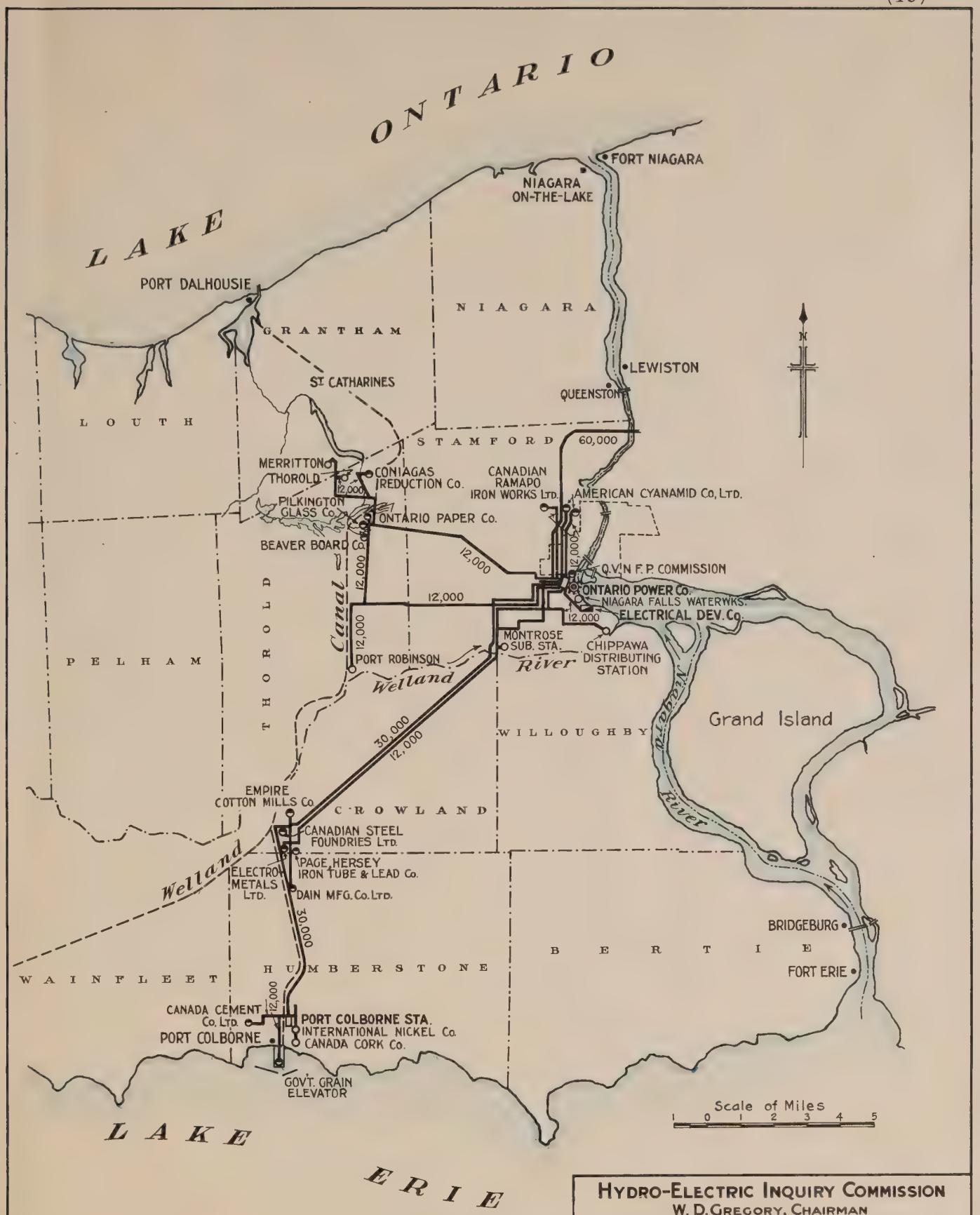



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
THE ONTARIO POWER COMPANY OF NIAGARA FALLS
(INCLUDING THE ONTARIO TRANSMISSION CO., LIMITED)

**MAP SHOWING LOCATION OF GENERATING STATION, TRANSFORMER STATIONS AND TRANSMISSION LINES**

Toronto, May 14th., 1923. Made by G.E.B., Checked by L.D.H.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

- GENERATING STATION
- HIGH TENSION TRANSFORMER STATIONS
- LOW TENSION " " OWNED BY O. P. Co.
- LOW TENSION " " OWNED BY CONSUMER
- HIGH TENSION " " OWNED BY ELECTRICAL DEV. Co.
- 12,000 TRANSMISSION LINES AND VOLTAGE

Humberstone Summer Resort,
H. J. Shore,
Ideal Baking Company,
Humberstone Shoe Company,
P. Noxell,
Woods and Sons,
R. A. Wilson,
E. Reeb,
Charles T. Grantham, (Empire Cotton Mills),
Metals-Chemical, Limited.

(b), all obligations and liabilities of the Power Company and of the Transmission Company under three contracts for the purchase of power from The Toronto Power Company of Ontario, Limited, dated respectively September 5th, 1914, October 13th, 1915, and March 17th, 1916, and (c), all obligations and liabilities of the Power Company for transmission on all power sold to the Ontario Paper Company, Limited, and the Beaver Wood Fibre Company, Limited. Further details may be obtained from pages 69 to 71 of the Tenth Annual Report of The Hydro-Electric Power Commission of Ontario for the year 1917.



By the terms of the agreement all books of the accounts of the two companies should have become the property of the purchaser, but it is understood that all of the original accounting books and records have not yet been delivered by the vendor. Due to this fact full information is not now available in respect to the accounts and accounting matters of The Ontario Power Company of Niagara Falls and the Ontario Transmission Company prior to the date of purchase.

Extensions of the Ontario Power Company.

After the properties of the Ontario Power Company were taken over by the Hydro-Electric Power Commission of Ontario as at August 1st, 1917, the Commission received, from the Commissioners of the Queen Victoria Niagara Falls Park,

Northwestern Lumber Dealers,
R. A. Dorrie.
Canal Boating Company.
Northwestern Iron Company.
J. Sewell.
Trade and Commerce.
C. C. Gibson.
R. Smith.
Charles C. Crosbaugh (Lyrie Baton Office).
Detroit-Cleveland, Inc.

(b) All subsidiary and affiliates of the Lake Company and of the Transportation Company whose stocks constituted the property of Lake Superior Iron Company of Canada, Limited, dated September 21, 1914, October 21st, 1919, and June 17th, 1919, and (c) all subsidiaries and affiliates of the Lake Superior Iron Company on all power held by the Canadian Lake Superior Corporation, and the Lake Superior Iron Company, Limited. Further details may be obtained from pages 69 to 75 of the Lake Superior Report of the Dominion-Canada Power Commission of Canada for the year 1921.

By the terms of the agreement all stocks of the companies of the two companies should have become the property of the purchaser, but it is doubtful that all of the original accounting books and records have not yet been delivered to the company. The by this time this information is not now available in reference to the accounts and accounting methods of the Canadian Lake Superior Company of Sault Ste. Marie and the Canadian Transportation Company prior to the date of purchase.

Subsidiaries of the Canadian Lake Superior.

After the acquisition of the Canadian Lake Superior were taken over by the Dominion-Canada Power Commission of Canada on 21 August 1919, the following also involved, from the Commissioners of the Lake Superior Company,

permission to construct a third conduit, known as the "Third Pipe Line", and the construction of this conduit was completed in the Spring of 1919. Two new generating units, Nos. 15 and 16, were added in a new extension of the power house and the capacity of the plant was increased to approximately 200,000 horse-power. At October 31st, 1921, the Hydro-Electric Power Commission had advanced $3,515,094.93, to the Ontario Power Company in connection with this construction.

On April 20th, 1922, an accident occurred which resulted in the destruction of units Nos. 15 and 16, and considerable damage by water to a number of other units causing a very large temporary reduction in the capacity of the plant. Generators Nos. 15 and 16 have not as yet been replaced and the present capacity of the plant is about 175,000 horse-power. Full details of the accident are given in a report to the Hydro-Electric Inquiry Commission by Mr. Walter J. Francis, dated November 13th, 1922.



## Description of the Plant.

The hydro-electric development of the Ontario Power Company is located on the Canadian side of the Niagara River in the immediate vicinity of the Horse-shoe Falls, the headworks being about a mile above the Falls, and the power house in the gorge a short distance downstream from the Falls.

The headworks, consisting of an intake, an outer forebay, a screen house, an inner forebay, and a gate-house, are built of concrete and stonework and the principal buildings are monumental in design.

Three underground conduits convey the water from the headworks to the

penstocks leading to the turbines in the power house. The conduits are approximately 6,500 feet in length and have a total drop of 28 feet from the head-gates to the inlets of the penstocks.

The first conduit was made of steel plate and is designated No. 1. It is of circular section with an internal diameter of 18 feet. A full description of this conduit in its present condition is given in a report to the Hydro-Electric Inquiry Commission by Mr. Walter J. Francis, dated September 26th, 1922.

The second conduit, No. 2, is constructed of reinforced concrete and is adjacent to No. 1, and on the river side thereof. The section of No. 2 is that known as a "hydrostatic chord" and has an area equivalent to that of a circle 18 feet in diameter. It was constructed in the years 1909 and 1910.



The third conduit, known as No. 3, is of wood-stave construction, of circular section with an internal diameter of 13.5 feet. It was constructed after the Ontario Power Company had been purchased by the Hydro-Electric Power Commission of Ontario, and was completed in 1919.

The water is admitted to the conduits by means of Stoney sluice head-gates, there being one head-gate for each conduit, all located in the gate-house. A surge tank is connected to each conduit.

Sixteen steel penstocks embedded in concrete carry the water from the conduits to the main units in the power house, one penstock for each main unit. Nos. 1 to 12, inclusive, are 9 feet in diameter, Nos. 13 and 14 are 9.5 feet in diameter, and Nos. 15 and 16 are 10.5 feet in diameter. Johnson valves are installed in penstocks Nos. 12 to 16 and gate valves are connected to the others.

The power house is about 780 feet long and is located at the water's edge

at the base of the cliff.

In the original plant there were fourteen main units in addition to the exciters. In 1919 main units Nos. 15 and 16 were added.

The turbine rating of main units Nos. 1 to 7 is 11,800 horse-power each; of Nos. 8 to 12 is 15,000 horse-power each; of Nos. 13 and 14 is 16,000 horse-power each, and of Nos. 15 and 16 is 18,000 horse-power each.

Units Nos. 1 to 6 are operated from conduit No. 1; unit No. 7 is operated from conduit No. 1 or No. 2; units Nos. 8 to 12 are operated from conduit No. 2; units 13 and 14 are operated from conduit No. 2 or No. 3, and units Nos. 15 and 16 were operated from conduit No. 3.



All generating units are of horizontal shaft type and the net turbine head is estimated by the engineers of the Hydro-Electric Power Commission to be about 180 feet.

Generators Nos. 1 to 3 are 7,500 kilowatts each, generators Nos. 4 to 14 are 8,776 kilowatts each, and generators Nos. 15 and 16 were 12,000 kilowatts each. Unit No. 15 commenced operation on June 3rd, 1919, and unit No. 16 on August 12th, 1919. All these generators are three-phase, 25-cycle, 12,000-volt. The combined ordinary rating of the sixteen units is 143,000 kilowatts, or about 191,000 horse-power at 80 per cent. power factor.

The accident to the two 12,000 kilowatt generators on April 20th, 1922, reduced the nominal rated capacity of the plant by 24,000 kilowatts or 32,000 horse-power.

The maximum output obtained from the plant with three conduits and sixteen generators in service is stated to have been about 202,000 horse-power. The output with conduit No. 1 alone is stated to be 59,000 horse-power. The surge

tank installed with this conduit is said not to function adequately when operating alone.

The output of conduit No. 1, with No. 2 in service, is said to be about 66,000 horse-power. The output of conduit No. 2, with No. 1 in service, is said to be about 94,000 horse-power. The output of conduit No. 3, with No. 1 and No. 2 in service, is said to be about 40,000 horse-power, and the total normal output with three conduits is about 200,000 horse-power. It will be noted that this output of 200,000 horse-power is 9,000 horse-power in excess of the combined ordinary horse-power rating of the sixteen generating units in the plant. This is due to the fact that the capacity of units Nos. 1 to 14 was increased by the increase in the water supply due to the installation of the third conduit.



When the accident occurred on April 20th, 1922, No. 15 and No. 16 generators were destroyed and their capacity was lost, but the water unused by them is now available for the other machines.

The peak capacity of the plant may therefore be considered as approximately 160,000 horse-power previous to the installation of the third conduit; 200,000 horse-power after the third conduit and generators No. 15 and No. 16 were installed and previous to the accident; and about 175,000 horse-power since the accident. The records show that an actual output of about 130,000 kilowatts or 174,000 horse-power has been obtained during recent months.

Under peak load conditions the power obtained from the water is stated to be approximately 15 horse-power per cubic foot per second, and on this assumption the maximum water used with sixteen machines would be $\frac{200,000}{15} = 13,300$ cubic feet per second; with No. 1 and No. 2 conduits and generators Nos. 1 to

14, the amount of water used would be $\frac{160,000}{15}$ = 10,700 cubic feet per second, and with three conduits and fourteen machines as at present the water used would be $\frac{175,000}{15}$ = 11,700 cubic feet per second.

The gross head of this development is about 215 feet, and accepting the value of 15 horse-power per cubic foot of water per second, the overall efficiency is about 61 per cent.

The Main Transformer and Distributing Station.

The main transformer and distributing station is located on the top of the hill about 500 feet from the crest of the cliff at the rear of the power house and contains switching, operating and control apparatus, as well as the high voltage equipment. Communication is established between the power house and the transformer station by tunnels in which the 12,000-volt cables are carried, and by shafts in which elevators are installed.



Further details of the Ontario Power Company's plant may be found in the reports of Mr. Walter J. Francis to the Hydro-Electric Inquiry Commission on the "Principal Characteristics of H. E. P. C. Plants", dated October 10th, 1922, and the "Description of the Plant of The Ontario Power Company of Niagara Falls", dated March 6th, 1923.

The plant and System of the Ontario Power Company is operated in parallel with the other generating stations at Niagara Falls, supplying power to private consumers, to the Hydro-Electric Power Commission, and for export. The details of the combined operations of the various plants are discussed in a separate report on the Niagara System in which are also discussed the growth and other characteristics of the market, the data on population and so forth.

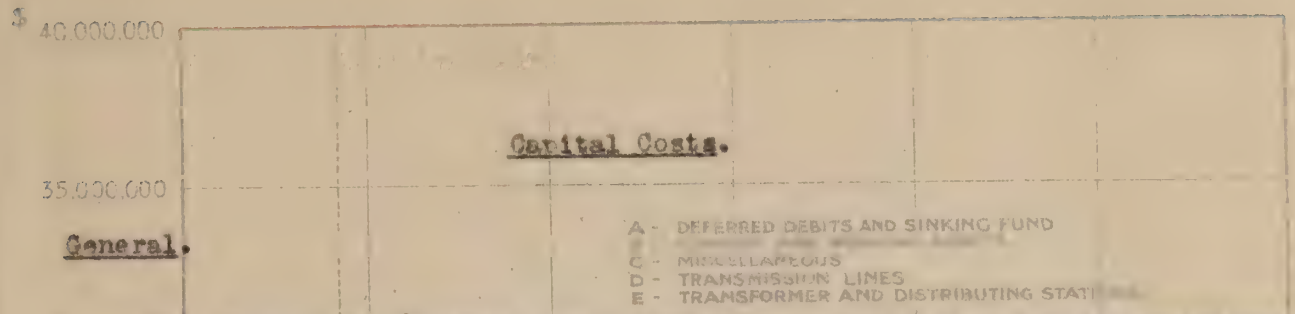
The volume of water-used would be $\frac{1,000,000}{12} = 83,333$ cubic feet per minute, and with some inaccuracy one further assumes as a pressure the value that would be $\frac{142,000}{12} = 11,700$ cubic feet per second.

The power that of this hydro-power is about 12 tons, and wherefore the value of it amounts per units for of water per second. The overall efficiency is about 81 per cent.

The main transformer and distribution station is located on the top of the hill about 100 feet [illegible] the cliff at the rear of the power house and contains switching, operating and control apparatus, as well as the high voltage equipment. Communication is established between the power house and the transformer station by means of the 12,000-volt cables and control, and by wires in which telephones are installed.

Further details of the Cruachy Power Company's plant may be found in the Journal of Mr. Philip C. Powell to the Institution-Centre Institute Conference on the "Electrical Transmission", of Mr. A. M. Clayton, Mr. Cliffe, Mr. Stott, and Mr. "Description of the Plant of the Cruachy Power Company of Glasgow Ltd", Mr. Sandy Ely, etc.

The plant and system of the Cruachy Power Company is operated in parallel with the river generating stations of Glasgow Corp., supplying power to private consumers, to the Corp.-Electric Power Companies, and for export. The details of the combined operations of the various plants are discussed in a separate report in the Glasgow Corp. in which are also discussed the prices and other characteristics of the service, the rate of depreciation and so forth.




## Capital Costs.

### General.

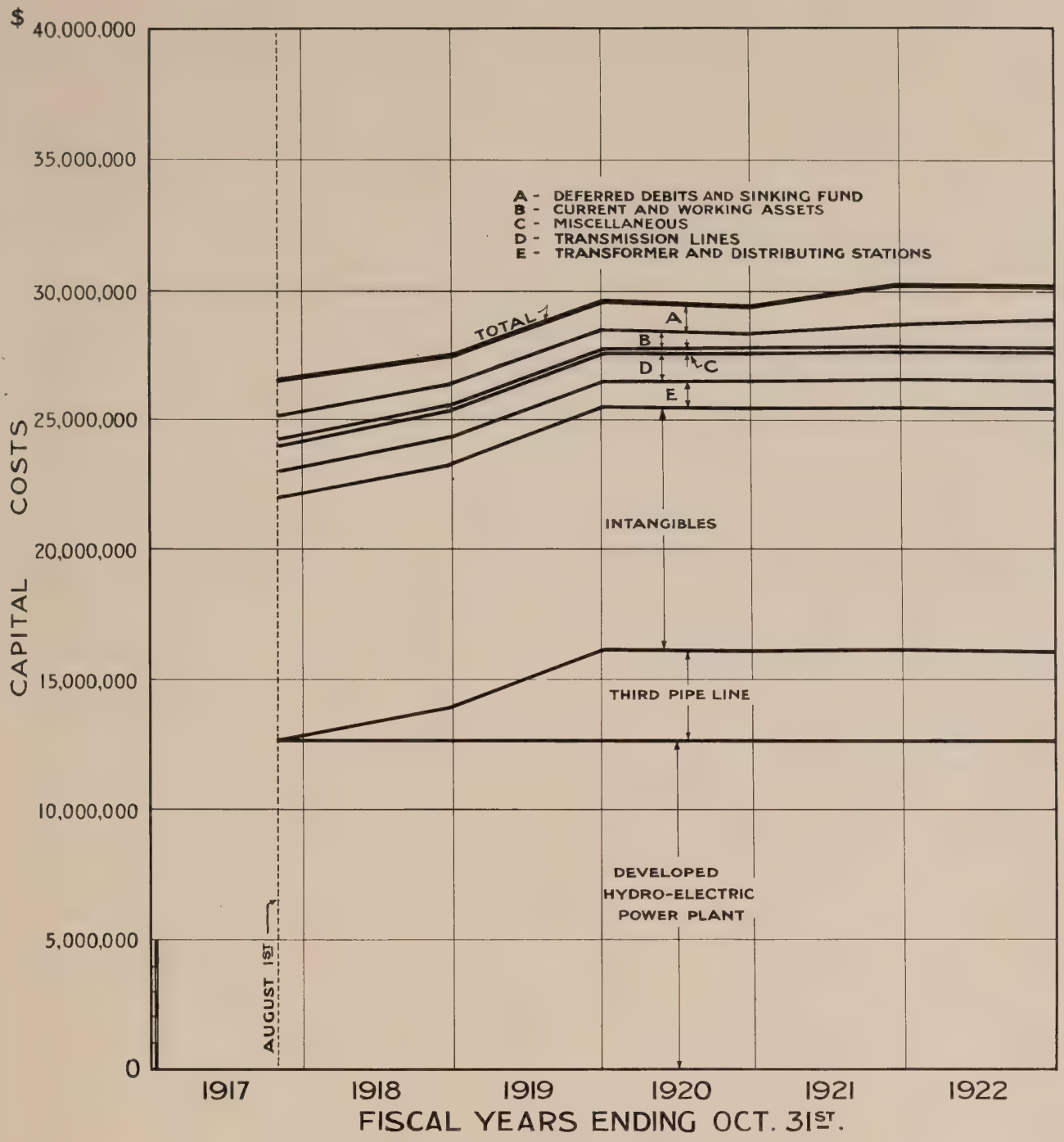
The figures for capital costs given in the table below and plotted diagrammatically and shown on the sheet of curves on page 18 were obtained directly, or deduced from Exhibit I of the report of Messrs. Price, Waterhouse & Co. to the Hydro-Electric Inquiry Commission dated October 9th, 1922. The figures for the fiscal year 1922 have been obtained from the balance sheet of the Ontario Power Company prepared by Messrs. Clarkson, Gordon & Dilworth, submitted on March 15, 1923.

Table of Progressive Capital Costs



| Capital Assets | As at August 1st, 1917 | As at Year Ending October 31st, 1918 | 1919 |
|---|---|---|---|
| Power Development | $12,650,276 | $12,650,276 | $12,650,276 |
| Third Pipe Line Extension | - | 1,349,171 | 3,510,441 |
| Intangible Assets | 9,304,113 | 9,304,113 | 9,304,113 |
| Transformer and Distributing Stations | 1,040,000 | 1,040,000 | 1,040,000 |
| Transmission Lines | 967,862 | 1,057,323 | 1,119,000 |
| Miscellaneous Assets | 193,130 | 168,614 | 115,078 |
| Current and Working Assets | 914,331 | 806,561 | 793,515 |
| Deferred Debits, Sinking Fund, Etc. | 1,377,222 | 1,060,366 | 1,017,052 |
| Totals | $26,446,934 | $27,436,424 | $29,549,475 |

| Capital Assets | As at Year Ending October 31st, 1920 | 1921 | 1922 |
|---|---|---|---|
| Power Development | $12,650,276 | $12,650,276 | $12,650,276 |
| Third Pipe Line Extension | 3,494,494 | 3,515,098 | 3,514,677 |
| Intangible Assets | 9,304,113 | 9,304,113 | 9,304,113 |
| Transformer and Distributing Stations | 1,040,000 | 1,040,000 | 1,040,000 |
| Transmission Lines | 1,116,841 | 1,138,347 | 1,138,033 |
| Miscellaneous Assets | 110,225 | 92,928 | 42,619 |
| Current and Working Assets | 620,749 | 880,155 | 1,090,501 |
| Deferred Debits, Sinking Fund, Etc. | 969,886 | 1,560,226 | 1,286,255 |
| Totals | $29,306,584 | $30,181,140 | $30,066,369 |




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

THE SYSTEM OF

THE ONTARIO POWER CO. OF NIAGARA FALLS

# PROGRESSIVE CAPITAL COSTS

Toronto, May 14th., 1923. Made by S.R.W. Checked by L.D.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

The procedure described below has been followed in subdividing the first item in Exhibit I of the Price, Waterhouse & Co. report into:

(a) Developed Plant
(b) Transformer and Distributing Stations
(c) Transmission Lines
(d) Intangible values

On page 9 of that report the value of fixed assets as determined by Mr. Clarkson for October 31st, 1918, is $14,746,599, neglecting the Third Pipe Line Extension.

The value of the fixed assets as determined by the Hydro-Electric Power Commission on July 31st, 1919, is from Exhibits V and VI of the same report,

| | |
|---|---|
| General Properties, Ontario Power Company (Exclusive of Third Pipe Line Extension) | $12,036,188 |
| Ontario Transmission Company, | 2,047,578 |
| Combined | $14,083,766 |



This total is less than the figure of nine months previous by $653,833, and there is no indication of the reason for the difference.

Taking Mr. Clarkson's figure of $10,304,113 for rights, franchises, good-will, etc., as representing the intangibles, and subtracting this value from the total value given in the first item of Exhibit I, October 31st, 1919, in the Price, Waterhouse & Co. report, the value for fixed assets is found as $14,809,276, which is $725,510 greater than the Hydro-Electric Power Commission's value of three months previous, and $61,677 more than Mr. Clarkson's figure for October 31st, 1918.

Dividing this figure $14,809,276 for fixed assets on October 31st, 1919, in the proportions given in Exhibits V and VI shown above as $12,036,188, and $2,047, 578, there results: $12,650,276 for developed plant, and $2,159,000 for transformer and distributing stations and transmission lines. This latter item

The intangible asset value has been defined in accordance with exact lines in Exhibit I of the report, Statements 4 to report item,

(a) Developed Plant
(b) Generators and Distributing Stations
(c) Transmission Lines
(d) Intangible values

On page 2 of that report the value of fixed assets as determined by Harmon for October 31st, 1918, is $14,[illegible], excluding the Entre Ríos Line intangibles.

The value of the fixed assets as determined by the Ogden-Electric Power Commission on July 31st, 1919, in Item Exhibit 7 and 11 of the same report,

| | |
|---|---|
| General Property | |
| Electricity [illegible] for the Commission | $21,[illegible] |
| Entre Ríos Transmission Company, | [illegible] |
| Combined | $14,386,758 |



This value is less than the figure of the values shown previously by $[illegible], and there is no indication of the reason for the difference.

Taking the Harmon's figure of $14,[illegible] for figure, Transmission, Entre Ríos, as representing the investment, and subtracting this value from the total value given in the first item of Exhibit I, October 31st, 1919, in the report, Statements 4 to, report, the value for fixed assets is found as $14,[illegible], which is $[illegible] greater than the Ogden-Electric Power Commission's value of three months previous, and $[illegible] more than the Harmon's figure for October 31st, 1918.

Deducting this figure $14,[illegible] for fixed assets as October 31st, 1919, in the proportion given in Exhibits 7 and 11 above leaves as $[illegible], and $[illegible], for, State Tramlines $[illegible] for developed plant, and $[illegible] for transformers and distributing stations and transmission lines. This leaves the

is divided into $1,040,000 for transformer and distributing stations, and $1,119,000 for transmission lines, following the same proportions as in Exhibit VI and considering items 1, 5, 6 and 7 to represent transmission lines.

To obtain the figures for the table and for plotting the curves, the amounts of $12,650,276 and $1,040,000, for developed plant and transformer and distributing stations respectively, were considered to remain constant; and any variations in the fixed assets other than the third pipe line extension were considered to affect only the "transmission lines". These figures are probably as close as can be obtained unless the original books of the Company are made available. The intangibles are inserted in the table as $9,304,113 instead of $10,304,113 as Messrs. Price, Waterhouse & Co. subtract $1,000,000 of stock of The Ontario Transmission Company, Limited, and do not include it as an asset.



The subdivided capital costs of the plant of the Ontario Power Company as given by Mr. Walter J. Francis in the report entitled "Principal Characteristics of H. E. P. C. Plants" are as follows: Intangibles including lands and water rights, $10,000,000; dams and water structures, $5,927,193; power house, $2,874,566; equipment, $3,232,306; total $22,034,065. This does not include the properties of The Ontario Transmission Company, Limited.

The following table shows briefly the change in the financial position of the Ontario Power Company since August 1st, 1917:

## A S S E T S

| | August 1st, 1917 | October 31st, 1921 | October 31st, 1922 |
|---|---|---|---|
| Plant, Real Estate, etc., and Goodwill | $25,155,380 | $28,740,758 | $28,689,623 |
| Less Capital Stock of the Ontario Transmission Co. | 1,000,000 | 1,000,000 | 1,000,000 |
| | $24,155,380 | $27,740,758 | $27,689,623 |
| Current and Working Assets and Deferred Debits | 2,291,554 | 2,440,382 | 2,376,766 |
| Totals | $26,446,934 | $30,181,140 | $30,066,389 |

## L I A B I L I T I E S

COPY

| | August 1st, 1917 | October 31st, 1921 | October 31st, 1922 |
|---|---|---|---|
| Capital Stock | $10,000,000 | $10,000,000 | $10,000,000 |
| Bonds and Debentures of the Companies | 14,450,000 | 10,858,000 | 10,691,000 |
| Advances from H.E.P.C. Expenditures on Third Pipe Line. | - | 3,515,095 | 3,514,677 |
| Re Retirement of Bonds | - | 3,200,000 | 3,200,000 |
| Current & Accrued Liabilities | 1,097,962 | 447,421 | 363,432 |
| Reserve for Renewals | 880,833 | 1,498,607 | 1,767,026 |
| Sinking Fund in respect of H.E.P.C. Debentures and advances including accrual. | - | 174,581 | 11,310 |
| Debentures of the Power Company and Bonds of the Transmission Company, including accrual | 18,139 | 10,005 | 10,248 |
| Reserve for Contingencies | - | 418,234 | 454,748 |
| Surplus | - | 59,197 | 53,948 |
| Totals | $26,446,934 | $30,181,140 | $30,066,389 |

The increase in the value of plant, real estate, etc., and goodwill, is almost entirely due to the construction of the third pipe line, and the

extension of the power house and the installation of the two new generating units.

The decrease in bonds and debentures of the Company due to retirement of bonds and debentures of the Ontario Power Company and of the Ontario Transmission Company, is shown in detail below.

The reserve funds are discussed on pages 39 to 50.

Bonds and Debentures.

The Funded Debt of $14,450,000 at August 1st, 1917, was in respect of the following Mortgage Bonds and Debentures:



(1) First Mortgage, Five Per Cent, Sinking Fund Gold Bonds of the Ontario Power Company, which are due February 1st, 1943.

The terms of the mortgage provide that annually on July 1st, payments of $1.00 for each electrical horse-power sold by the Company and paid for by the purchaser during the preceding year, shall be made by the Company to the Trustees for the purpose of a sinking fund to be used in the redemption of the bonds.

The status of this issue as at October 31st, 1921, was as follows:

| | | |
|---|---|---|
| Authorized Issue | | $12,000,000 |
| Total Amount Sold | | 10,579,000 |
| Bonds Outstanding, August 1st, 1917, | | 9,834,000 |
| Bonds Retired, | | |
| August 1st, 1917, to October 31st, 1918, | $158,000 | |
| October 31st, 1918, to October 31st, 1919, | 149,000 | |
| October 31st, 1919, to October 31st, 1920, | 152,000 | |
| October 31st, 1920, to October 31st, 1921, | 157,000 | |
| August 1st, 1917, to October 31st, 1921, | | 616,000 |
| Bonds outstanding October 31st, 1921, | | $ 9,218,000 |

In addition to the bonds outstanding on October 31st, 1921, $1,400,000 of bonds were pledged to the Bank of Montreal as collateral security for an advance

of $1,200,000 to provide funds for the construction of the third pipe line extension.

(2) First Mortgage Five Per Cent. Gold Bonds of The Ontario Transmission Company, Limited, which are due May 1st, 1945. The status of this issue as at October 31st, 1921, was as follows:

| | | |
|---|---|---|
| Amount authorized and sold | | $2,000,000 |
| Bonds outstanding at August 1st, 1917, | | 1,772,000 |
| Bonds retired, | | |
| August 1st, 1917, to October 31st, 1918, | $ 33,000 | |
| October 31st, 1918, to October 31st, 1919, | 18,000 | |
| October 31st, 1919, to October 31st, 1920, | 43,000 | |
| October 31st, 1920, to October 31st, 1921, | 48,000 | |
| August 1st, 1917, to October 31st, 1921, | | 142,000 |
| | | $1,630,000 |

The sinking fund agreement provides that $50,000 shall be paid annually on July 1st, for retirement of the bonds.



(3) Six Per Cent. Gold Debentures of The Ontario Power Company of Niagara Falls, which fell due and were retired on July 1st, 1921, as follows:

| | | |
|---|---|---|
| Authorized issue | | $3,000,000 |
| Bonds outstanding August 1st, 1917, | | 2,844,000 |
| Bonds retired, | | |
| August 1st, 1917, to October 31st, 1918, | $ 38,000 | |
| October 31st, 1918, to October 31st, 1919, | 36,000 | |
| October 31st, 1919, to October 31st, 1920, | 17,000 | |
| October 31st, 1920, to October 31st, 1921, | 2,713,000 | |
| August 1st, 1917, to October 31st, 1921 | | 2,844,000 |

(4) Six Per Cent. Twenty-year Bonds of the Hydro-Electric Power Commission of Ontario, guaranteed by the Province, were issued on June 24th, 1921, to retire the balance of the Six Per Cent. Gold Coupon Debentures of the Ontario Power Company, outstanding at October 31st, 1920, and which fell due on July 1st, 1921,

and amounted at that time to $2,753,000 as shown above. The status of this issue at October 31st, 1921, was as follows:

| | |
|---|---|
| Authorized issue | $3,300,000.00 |
| Amount sold | 3,200,000.00 |
| Proceeds from the sale of bonds | 3,039,782.26 |
| Amount provided from general funds of the Ontario Power Company | 71,375.44 |
| Total | $3,111,157.70 |
| Face value of debentures of the Ontario Power Company outstanding at October 31st, 1921, | 2,753,000.00 |
| American exchange on remittance for retirement of bonds | 358,157.70 |
| Total | $3,111,157.70 |

The sinking fund provision in respect to this issue of Six Per Cent. Twenty-year Bonds, requires a payment of one per cent. of the par value of the bonds annually on June 1st, throughout the twenty-year period.



The Funded Debt as at August 1st, 1917, was thus decreased by the retirement of bonds of the Ontario Power Company and of the Ontario Transmission Company of the face value of $3,602,000, but liabilities were incurred in respect to the issue of $3,200,000 Six Per Cent. Twenty-year Bonds of the Hydro-Electric Power Commission, and the cash advance of $3,515,094.93 from the Hydro-Electric Power Commission for the construction of the third pipe line extension.

(5) Four Per Cent. Forty-year Gold Debentures of The Hydro-Electric Power Commission of Ontario, guaranteed by the Province, were provided for the purchase of the capital stock of The Ontario Power Company of Niagara Falls and The Ontario Transmission Company, Limited. The full amount of this issue, namely $8,000,000, was outstanding at October 31st, 1921, and at that date an initial

annual sinking fund provision of $100,000 was made out of revenue.

## Power Data.

The following table and the diagram on page 26 have been prepared to show the characteristics of the Ontario Power Company in terms of horse-power.

Table of Horse-power Developed, Conserved, Billed, etc.

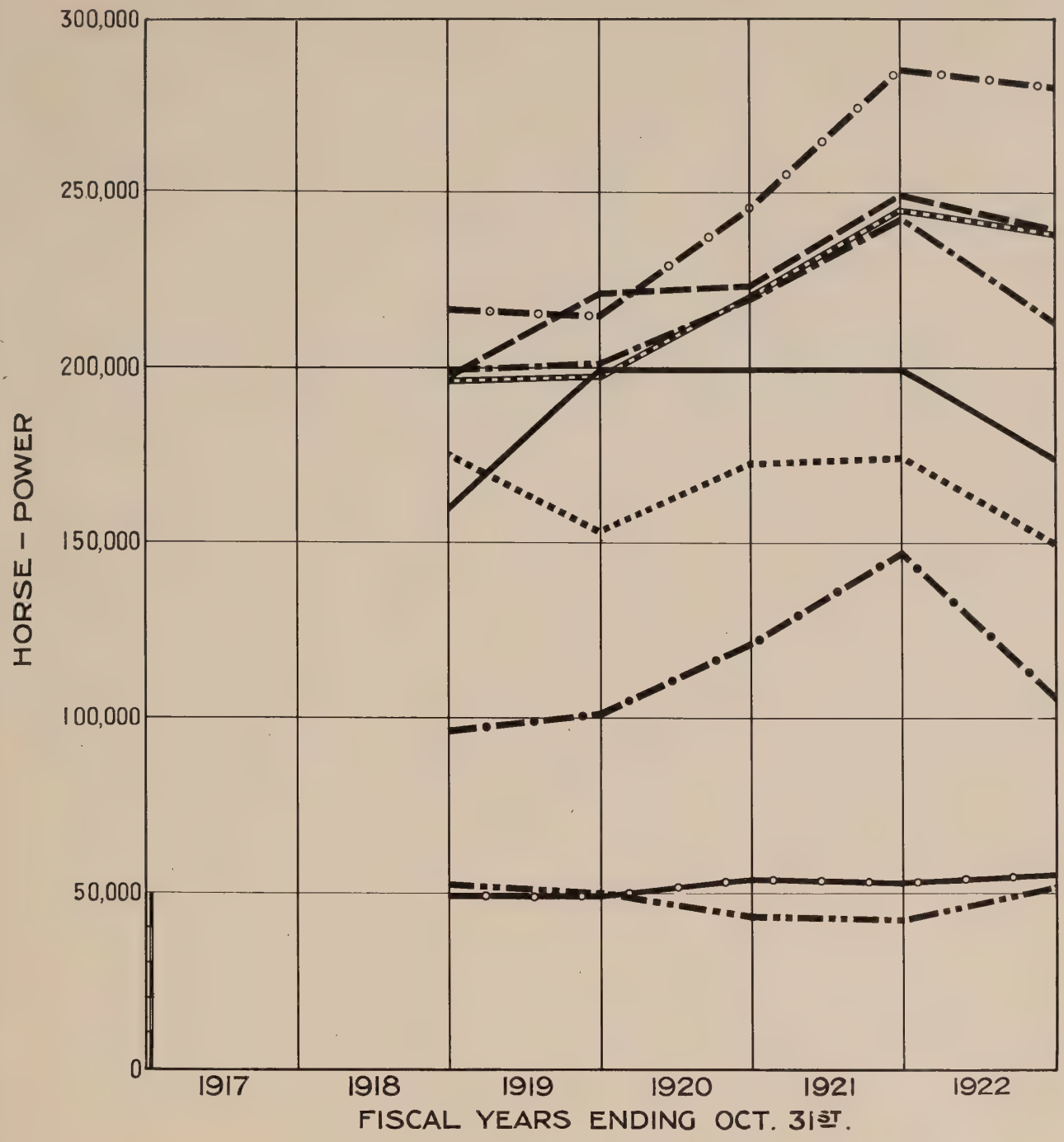
| | Fiscal Years Ending October 31st, | | | | |
|---|---|---|---|---|---|
| | 1918 | 1919 | 1920 | 1921 | 1922 |
| H.P. Developed | 160,000 | 200,000 | 200,000 | 200,000 | 175,000 |
| H.P. Developed plus Purchased | 198,047 | 222,125 | 224,033 | 249,908 | 240,458 |
| Average H.P. Consumed | 176,216 | 154,393 | 173,303 | 174,888 | 151,350 |
| Total H.P. Billed | 200,003 | 201,966 | 220,032 | 244,348 | 215,206 |
| H.P. Billed to H.E.P.C. Systems | 97,517 | 102,295 | 121,869 | 148,162 | 108,461 |
| H.P. Billed to Companies | 53,357 | 50,680 | 44,045 | 43,324 | 52,228 |
| H.P. Exported | 49,129 | 49,011 | 54,118 | 52,860 | 54,517 |
| Average of Monthly Peaks H.P. | 197,447 | 197,575 | 220,842 | 245,542 | 239,117 |
| Maximum Yearly Peak H.P. | 217,600 | 216,200 | 246,000 | 286,000 | 281,000 |



It will be noted that there are nine different classes of horse-power shown on the table and in the diagram. These may be explained as follows:

### Developed Horse-power.

The figures for plotting the curve showing the developed horse-power were obtained from the records of the Hydro-Electric Power Commission or were given by the engineers of the Commission and are the sums of the capacities of the various units installed in the Ontario Power Company's station with an allowance




H.P. Developed
H.P. Developed Plus Purchased
Average H.P. Consumed
Total H.P. Billed
H.P. Billed to H.E.P.C.
H.P. Billed to Companies
H.P. Exported
H.P., Average of 12 Monthly Peaks
H.P., Maximum Yearly Peak

Hydro-Electric Inquiry Commission
W. D. Gregory, Chairman
Economics of H.E.P.C. Distribution Systems
The System of
THE ONTARIO POWER CO. OF NIAGARA FALLS

# HORSE-POWER DATA

Toronto, May 14th., 1923. Made by G.E.B. Checked by L.J.H.
Walter J. Francis & Company
Consulting Engineers

for the increase of capacity due to the construction of the third pipe line extension.

Developed plus Purchased Horse-power.

The figures for horse-power purchased from various sources were obtained from the records of the Commission and were added to the developed horse-power above to give the totals for plotting this curve. For the period February 1st, 1920, to March 16th, 1922, an amount of 11,000 horse-power was delivered by the Toronto Power Company directly to the Electro-Metals, Limited, and this amount has been added to give the figures in the table as it was charged as purchased power against the Ontario Power Company but not shown in the load records. It should be noted that it is stated by the officials of the Hydro-Electric Power Commission that the various blocks of power purchased by the Hydro-Electric Power Commission at Niagara Falls are now "pooled" through the Ontario Power Company, and that all transactions except the item of 50,000 horse-power purchased from the Canadian Niagara Power Company and delivered directly to the Hydro-Electric Power Commission are recorded in the books of the Ontario Power Company to facilitate operations and book-keeping. A summary of the various contracts is given as an appendix at the end of this report.



Average Horse-power Consumed.

The average horse-power consumed in each of the fiscal years has been derived from the total number of kilowatt-hours given by the Hydro-Electric Power Commission as being the total kilowatt-hours supplied by the Ontario

for the Commission of Quality for as the maintenance of the first line line extension.

Operating the Electrical Distribution.

The climate for home-power production from solar energy was varying from the results of the Commission and were added to the analogous home-power above to give the totals for distribution mains. The the period February 1st, 1969, to March 31st, 1969, in amount of 1,700 kilowatt-hours was delivered by the Central Power Company directly to the Sheets-Electric, Inc., and this amount has been added to your the Power Supply Table to it was charged to produced power against the Sheets-Electric Company but may come in the last month. It should be noted that it is stated by the utilities of the Photovoltaic Power Commission that the various kinds of power produced by the Photovoltaic Power Commission of Illinois Utils are not "equal" between the Electric Power Company, and that all investigations concerning the line of 69,000 kilowatt-power-hours from the Solartic Illinois Power Company and delivered directly to the Sheets-Electric Power Commission are included in the means of the Central Power Company to facilitate operations and non-demand. A summary of the various contracts is given as an appendix at the end of this report.

Illinois Hydro-power Consumed.

The average kilowatt-hours is such of the Illinois Power has been derived from the total number of kilowatt-hours given by the Photovoltaic Power Commission as from the total kilowatt-hours supplied by the Central

Power Company in the various years including purchased power. As no kilowatt-hour figures were available covering the 11,000 horse-power mentioned above as being delivered by the Toronto Power Company to Electro-Metals, Limited, this load has been expressed in kilowatt-hours at a stated load factor of 95 per cent. and so included in the totals. The figures used in the table were obtained by dividing the yearly kilowatt-hour consumption by 8760, the number of hours in a year, and by the constant .746 to reduce kilowatts to horse-power.

Billed Horse-power.

The curve of billed horse-power was plotted from data given by the engineers of the Hydro-Electric Power Commission. A subdivision has been made between horse-power billed to the Hydro-Electric Power Commission, to private companies, and exported to the United States. Power delivered to the Hydro-Electric Power Commission of Ontario is billed as horse-power only, but in the case of power billed to private companies and to the Niagara, Lockport Company, for export, there is an average monthly horse-power charge, and in addition a kilowatt-hour charge for excess power. The excess kilowatt-hours billed have been reduced to average horse-power at 100 per cent. load factor and added to the average yearly horse-power billed to obtain the figures given in the table for H.P. Billed to Companies and H.P. Exported. As the proportion of this excess power is very small, reducing as it does to a yearly average of 1,000 or 2,000 horse-power calculated at 100 per cent. load factor, only a very small change would result if any other load factor were assumed for the excess, and as the contract arrangements provide for a net integrated additional amount only, it

was impracticable to determine accurately the load factor for the excess power so billed.

Average of Monthly Peaks.

The figures for the average of the monthly peak horse-power were taken directly from the operating records of the Ontario Power Company, and include purchased power.

Maximum Yearly Peak Horse-power.

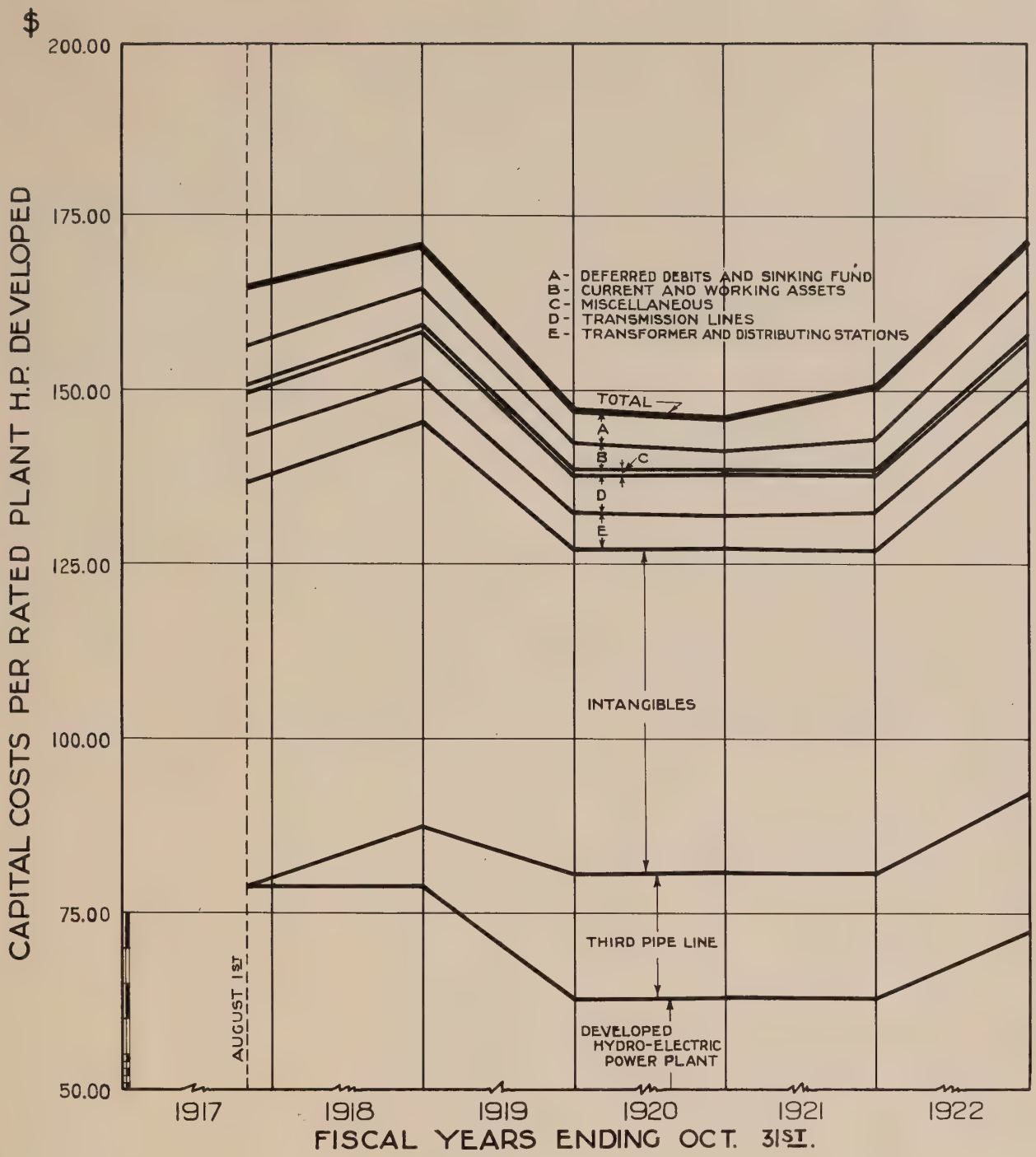


The figures for the maximum yearly peak horse-power were taken directly from the operating records of the Ontario Power Company, and include purchased power.

A study of these curves indicates that the diversity factor is small being about sufficient to offset the transmission losses.

Capital Costs per Horse-power Developed.

The diagram included as page 30 and the table on page 31 indicate the fractional capital costs per rated plant horse-power developed at different points of delivery, based on figures showing the capital costs of the System and the horse-power data given above. This sheet of curves, therefore, indicates the capital costs per rated plant horse-power with the spaces between adjacent curves indicating that portion of the total (delivered) capital cost per horse-power chargeable against each of the items of the table as follows:




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

THE SYSTEM OF

THE ONTARIO POWER CO. OF NIAGARA FALLS

**CAPITAL COSTS**

**PER HORSE-POWER DEVELOPED**

Toronto, May 14th., 1923. Made by [illegible], Checked by [illegible]

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Table of Capital Costs per Rated Plant Horse-power Developed

| Rated Horse-power | As at August 1st, 1917 | As at Year Ending October 31st, 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|
| | 160,000 | 160,000 | 200,000 | 200,000 | 200,000 | 175,000 |
| Power Development | $79.06 | $79.06 | $63.25 | $63.25 | $63.25 | $72.29 |
| Third Pipe Line Extension | - | 8.43 | 17.55 | 17.47 | 17.58 | 20.08 |
| Intangible Assets | 58.15 | 58.15 | 46.52 | 46.52 | 46.52 | 53.17 |
| Transformer and Distributing Stations | 6.50 | 6.50 | 5.20 | 5.20 | 5.20 | 5.94 |
| Transmission Lines | 6.05 | 6.61 | 5.60 | 5.58 | 5.69 | 6.50 |
| Miscellaneous Assets | 1.21 | 1.05 | .58 | .55 | .46 | .24 |
| Current and Working Assets | 5.71 | 5.04 | 3.97 | 3.10 | 4.40 | 6.23 |
| Deferred Debits, Sinking Funds, etc. | 8.61 | 6.63 | 5.08 | 4.85 | 7.80 | 7.35 |
| Totals | $165.29 | $171.47 | $147.75 | $146.52 | $150.90 | $171.80 |



The figures for 1922 are given as at October 31st, and the costs per horse-power are increased due to the loss of capacity resulting from the accident which occurred on April 20th, 1922.

Total Revenues.

The table below giving the total revenues of the Ontario Power Company from 1918 to 1922 inclusive has been prepared by using the figures of Exhibit II of the report by Messrs. Price, Waterhouse & Co. on the "Investigation of the Accounts of the Ontario Power Company" dated October 9th, 1922, Hydro-Electric Inquiry Commission File No. 175-a, dated October 18th, 1922. These figures have been supplemented by more detailed figures from the accountants of the Hydro-Electric Power Commission of Ontario. The figures for 1922 are approximate and were obtained from the interim operating statement submitted by Mr. Clarkson under date of December 31st, 1922, Hydro-Electric Inquiry Commission File

Table of Capital Costs per Rated Plant Horse-power Analysed

| Rated Horse-power | As at Jan. 1st, 1917 | As at June 1st, 1918 | 1919 | 1920 | 1921 |
|---|---|---|---|---|---|
| | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 |
| Power Development | £79.06 | £79.06 | £82.25 | £85.25 | £95.29 |
| Extra pipe line Dynamics | - | Same | £7.22 | £7.22 | £8.22 |
| Internal Assets | 56.15 | 56.15 | 46.52 | 46.52 | 46.52 | 56.17 |
| Transformer and Distributing Station | 6.60 | 6.50 | 5.20 | 5.20 | 5.20 | 5.64 |
| Transmission Lines | 6.05 | 6.01 | 5.60 | 5.58 | 5.59 | 6.80 |
| Miscellaneous Assets | 4.21 | [illegible] | [illegible] | [illegible] | [illegible] | .41 |
| Interest and Sinking Funds | 3.71 | 3.85 | 4.37 | 5.23 | 5.27 | 5.23 |
| Overhead Costs, Costing Staff, etc. | 2.37 | 2.62 | 2.32 | 2.47 | 2.47 | 2.40 |
| Totals | £151.12 | £157.17 | £154.27 | £164.23 | £174.47 | £177.17 |

The figures for 1921 are taken from the Government Gazette, and the power per horse-power are included due to the fact of quantity remaining over the maximum which occurred on April 20th, 1922.



Equal Increase.

The table below giving the total percentage of the capacity power imposed from 1918 to 1922 inclusive has been prepared by using the figures of Exhibit II of the report by Messrs. Price, Waterhouse & Co. on the "Commercialisation" of the business of the Ontario River Improvement Extra Commission Ltd., Ont. Hydro-Electric Inquiry Commission File No. 17[illegible], Main Drawer 3[illegible], Ont. These figures have been revised by more detailed figures from the accountants of the Hydro-Electric Power Commission of Ontario. The figures for 1921 are approximate and were obtained from the capacity operating statement submitted by Mr. Chisholm under date of December 21st, 1921. Hydro-Electric Inquiry Commission File

No. 234-a, and supplemented by the detailed records of the Commission. The subdivided portions of the total revenues for 1921 and 1922 derived from private consumers and from exported power are close approximations. The sheet of curves on page 35 shows the revenues in graphic form.

Table of Total Revenues for Various Classes of Customers

| | Fiscal Year Ending October 31st, 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Power Sold to Hydro-Electric Power Commission | $892,742 | $957,905 | $1,182,567 | $1,712,354 | $1,906,927 |
| Power Sold to Private Companies | 684,799 | 622,400 | 615,386 | 620,750± | 657,119± |
| Power Sold for Export | 624,123 | 618,116 | 702,670 | 674,700± | 700,000± |
| Total Revenue | $2,201,664 | $2,198,421 | $2,500,623 | $3,007,804 | $3,264,046 |

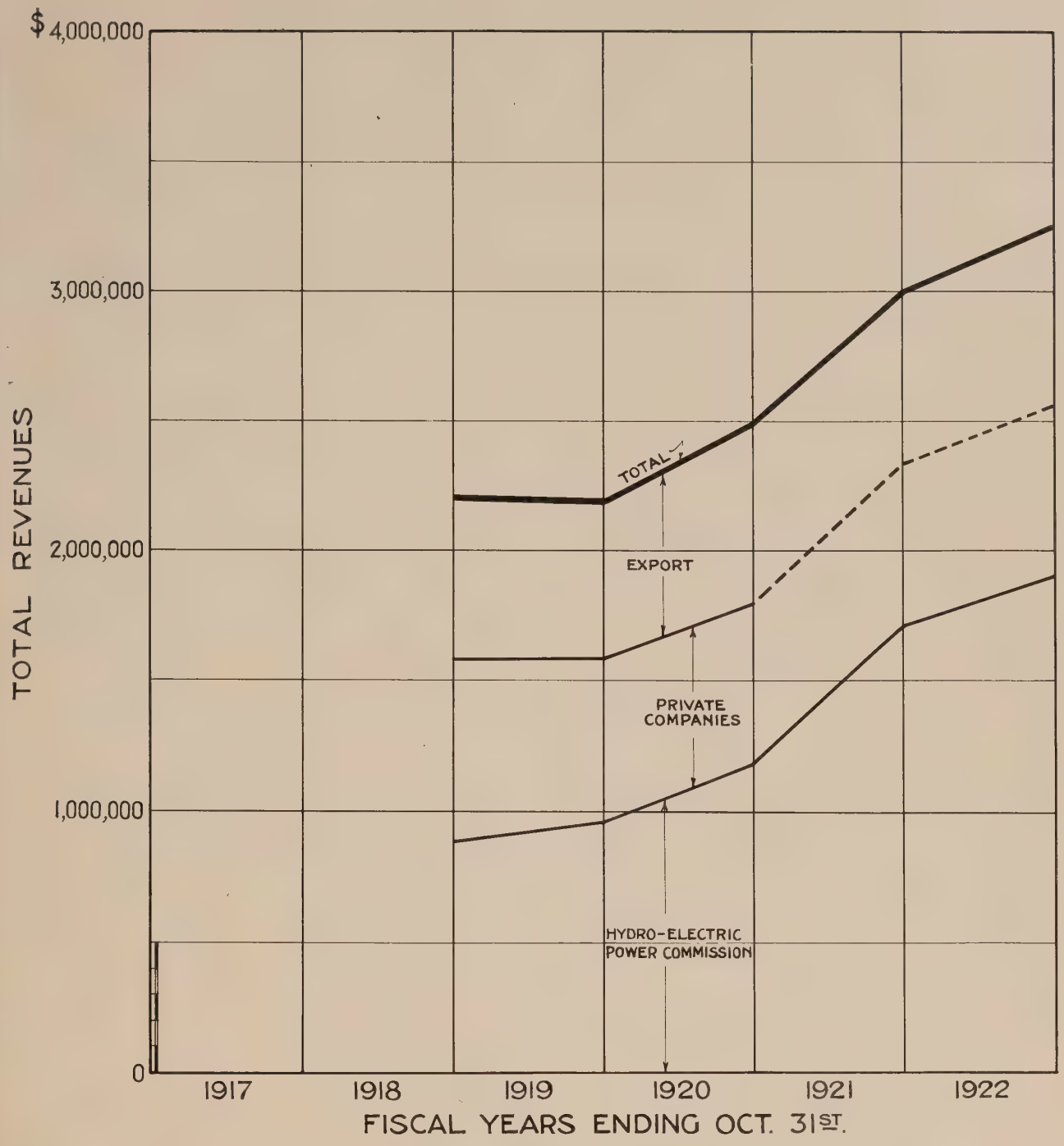


The figures for the fiscal year ending October 31st, 1918, have been obtained by reducing the figures for the period from August 1st, 1917, to October 31st, 1918, in the proportion of twelve to fifteen.

## Total Costs of Power.

The table on page 37 shows the costs of power subdivided under various headings for the years 1917 to 1921 inclusive. The figures are made up from Exhibit II of the Price, Waterhouse & Co. report dated October 9th, 1922.

The headings under which the various costs have been grouped are as follows:




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
THE SYSTEM OF
THE ONTARIO POWER CO. OF NIAGARA FALLS

# TOTAL ANNUAL REVENUES

Toronto, May 14th., 1923. Made by G.E.B. Checked by L.L.H.
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Operating Costs.

Operating costs include the wages of power house operators, linemen, station attendants, and so forth, supplies and all miscellaneous items usually grouped under this item.

Power Purchased.

Power purchased from other sources may be included under the head of operating costs but in the present instance it represents such a large item of cost that it has been grouped separately.



Maintenance.

Under maintenance have been placed all the items for labour and materials charged in the books of the Commission as against the individual portions of the plant, stations, lines, and distributing stations, and these have been grouped together, from the individual figures in the Price, Waterhouse & Co. report, to make one item.

Overhead and General Expense.

Under the heading of overhead and general expense are such items as the local executive and office payroll, taxes, insurance, audit fees, legal expense, miscellaneous office supplies and so forth, and in addition a portion of the administrative expense of the Hydro-Electric Power Commission, all in accordance with the Price, Waterhouse & Co. report.

Interest, Discount and Exchange.

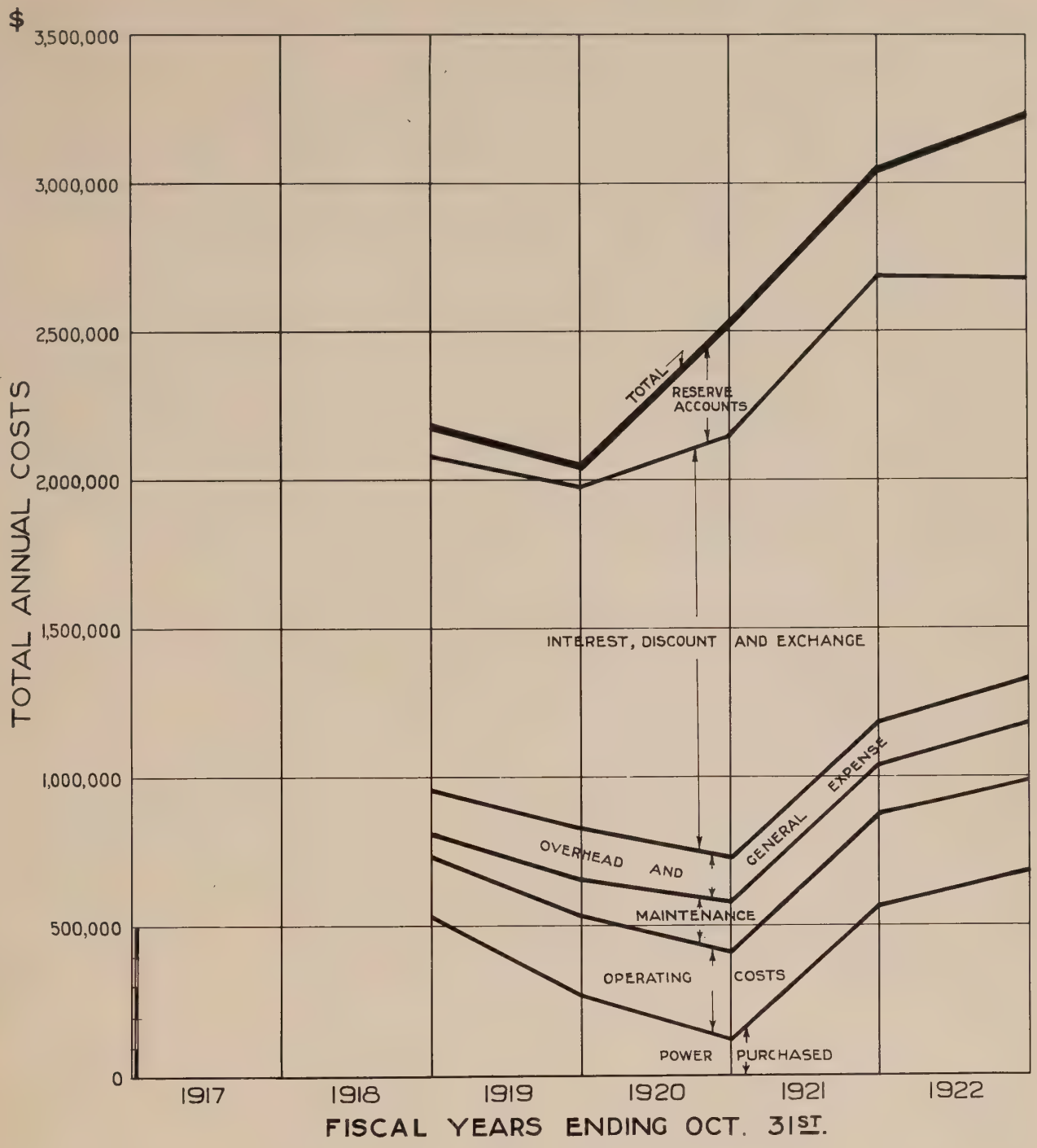
The figures for interest, discount and exchange include all interest charges on the bonds representing the capital invested in the System, the annual amount required to amortize the discount on the bonds during their life and all charges for American exchange on bond interest payments, sinking fund, deposits, etc. The exchange on remittances to retire the bonds due in 1921, amounted to $358,157.20, of which $6,829.09 was charged against operations in 1921, leaving a balance at October 31st, 1921, of $351,328.51. It is stated that it is the intention of the Company to amortize this exchange over a period of 20 years in which case this charge will form part of the cost of power to municipalities over that period.



Reserve Account.

The reserve accounts for Renewals, Sinking Fund and Contingencies have been combined in one reserve account as they do not seem to have been kept entirely separate, as indicated in the discussion of the reserve accounts on pages 39 to 50 of this report. The figures include all items shown as chargeable against renewals, and also charges against depreciation of furniture, construction plant, etc., in Exhibit II of the Price, Waterhouse & Co. report; reserves for sinking fund purposes and for contingencies, all obtained from the same report supplemented by later information and discussed in more detail later in this report.

The sheet of curves on page 36 is the direct plotting of the figures in the table on page 37, with the spaces between adjacent curves indicating the




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
THE SYSTEM OF
THE ONTARIO POWER CO. OF NIAGARA FALLS

# TOTAL ANNUAL COSTS

Toronto, May 14th., 1923. Made by [illegible], Checked by [illegible]
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

amount chargeable against that particular item. The figures are as follows:

Table of Total Annual Costs of Power

| | August 1st, 1917 to October 31st, 1918 | 1917-1918 Reduced to 12-month Basis | Year Ending October 31st, 1919 |
|---|---|---|---|
| Power Purchased | $ 663,421 | $ 530,737 | $ 273,385 |
| Operating Costs | 267,037 | 213,630 | 268,094 |
| Maintenance | 88,328 | 71,062 | 118,541 |
| Overhead and General Expense | 191,507 | 153,206 | 179,165 |
| Interest, Discount and Exchange | 1,394,708 | 1,115,766 | 1,142,597 |
| Reserve Accounts | 139,198 | 111,358 | 78,548 |
| Totals | $2,744,699 | $2,195,759 | $2,060,330 |

Table of Total Annual Costs of Power (Continued)



| | Fiscal Year Ending October 31st, 1920 | 1921 | 1922 |
|---|---|---|---|
| Power Purchased | $ 125,073 | $ 569,292 | $ 682,929 |
| Operating Costs | 295,598 | 309,912 | 311,469 |
| Maintenance | 158,129 | 164,706 | 191,239 |
| Overhead and General Expense | 160,711 | 139,232 | 148,581 |
| Interest, Discount and Exchange | 1,413,897 | 1,508,828 | 1,344,324 |
| Reserve Accounts | 389,365 | 359,959 | 369,509 |
| Totals | $2,542,773 | $3,051,929 | $3,248,051 |

Percentage Costs of Power.

The following table and sheet of curves included as page 38 show the cost figures as percentages of the total cost of power per annum, and these are included as a method of comparison with other systems or similar properties.

Table of Total Annual Costs of Power

| | August 1st,1917 to October 31st, 1919 | 1917-1919 reduced to 12-month basis | Year ending October 31st, 1919 |
|---|---|---|---|
| Power introduced | $ 127,075 | $ 849,292 | $ 882,929 |
| Operating Costs | 298,899 | 399,918 | 311,459 |
| Maintenance | 189,129 | 164,796 | 191,289 |
| Overhead and General Expense | 140,771 | 139,822 | 141,[illegible] |
| Interest, Discount and Exchange | 1,439,977 | 1,288,815 | 1,[illegible] |
| Interest Income | [illegible] | [illegible] | [illegible] |
| Total | $2,844,889 | $2,186,750 | $2,060,[illegible] |

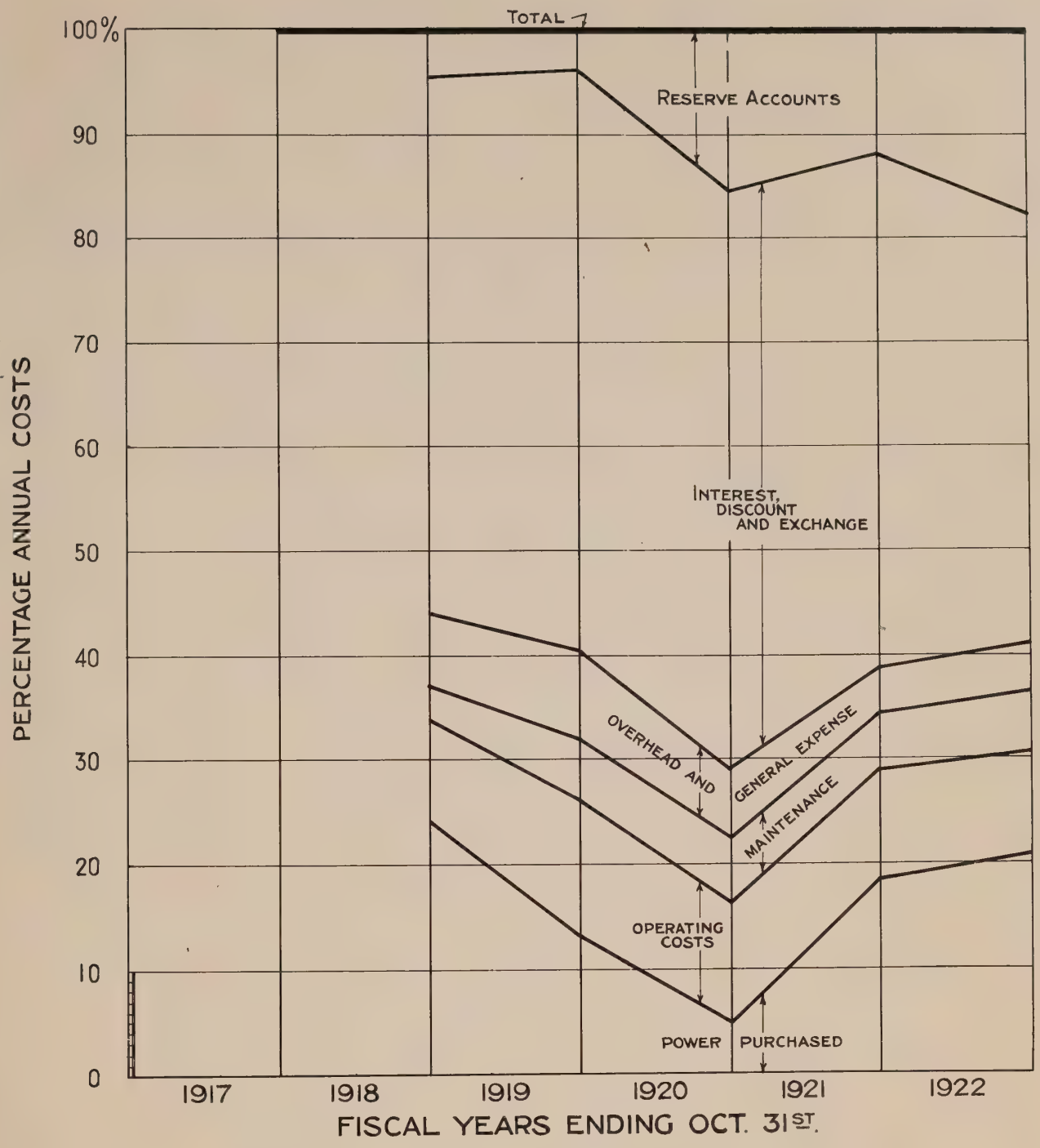
Cost of Power (Continued)

| | Fiscal Year Ending October 31st, 1920 | 1921 | 1922 |
|---|---|---|---|
| Power introduced | $ 128,075 | $ 849,292 | $ 882,929 |
| Operating Costs | 298,899 | 399,918 | 311,459 |
| Maintenance | 189,129 | 164,796 | 191,289 |
| Overhead and General Expense | 140,771 | 139,822 | 141,[illegible] |
| Interest, Discount and Exchange | 1,439,977 | 1,288,815 | 1,[illegible] |
| Interest Income | [illegible] | [illegible] | [illegible] |
| Total | $2,842,775 | $2,021,929 | $2,[illegible],081 |



Information Furnished by Company.

The following facts and charts of Massachusetts Institute of Technology are presented as illustrations of the kind of data it proposes to obtain, and those data indicate as a method of connection with other systems or similar organizations.




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

THE SYSTEM OF

THE ONTARIO POWER CO. OF NIAGARA FALLS

**ANNUAL COSTS SUBDIVIDED BY PERCENTAGES**

Toronto, May 14th., 1923. Made by G.S.B., Checked by L.L.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Table of Annual Costs Subdivided by Percentages

| | August 1st, 1917 to October 31st, 1918 | 1917-1918 Reduced to 12-month Basis | Year Ending October 31st, 1919 |
|---|---|---|---|
| Power Purchased | 24.2 | 24.2 | 13.3 |
| Operating Costs | 9.7 | 9.7 | 13.0 |
| Maintenance | 3.3 | 3.3 | 5.7 |
| Overhead and General Expense | 7.0 | 7.0 | 8.7 |
| Interest, Discount and Exchange | 51.4 | 51.4 | 55.7 |
| Reserve Accounts | 4.4 | 4.4 | 3.6 |
| Totals | 100.0% | 100.0% | 100.0% |

Table of Total Annual Costs Subdivided by Percentages (Continued)

| | Fiscal Years Ending October 31st, 1920 | 1921 | 1922 |
|---|---|---|---|
| Power Purchased | 5.0 | 18.6 | 21.0 |
| Operating Costs | 11.6 | 10.2 | 9.6 |
| Maintenance | 6.1 | 5.4 | 5.9 |
| Overhead and General Expense | 6.4 | 4.6 | 4.7 |
| Interest, Discount and Exchange | 55.6 | 49.4 | 41.3 |
| Reserve Accounts | 15.3 | 11.8 | 17.5 |
| Totals | 100.0% | 100.0% | 100.0% |



## Analysis of Reserve Accounts.

### Renewals Account.

The table below shows the amount set aside as reserve for renewals as given on pages 23 to 26 and in Exhibits V and VI of the report of Messrs. Price, Waterhouse & Co. on the investigation of the accounts of the Ontario Power Company, dated October 9th, 1922, Hydro-Electric Inquiry Commission

Table of Annual Costs Subdivided by Percentages

| | Period Jan.1,1917 to October 31st,1917 | 12½-year Reduced to 12-month Basis. | Year Ending October 31st, 1918 |
|---|---|---|---|
| Power Introduced | 32.2 | 24.2 | 17.0 |
| Operating Costs | 9.7 | 9.7 | 13.3 |
| Maintenance | 2.7 | 2.2 | 2.1 |
| Overhead and General Expense | 7.0 | 7.1 | 8.7 |
| Interest, Discount and Insurance | 32.4 | 41.4 | 32.7 |
| Reserve Accounts | 16.4 | 14.8 | 26.2 |
| Totals | 100.0% | 100.0% | 100.0% |

Table of Total Annual Costs Subdivided by Percentages (Continued)

| | Period Jan.1,1917 to October 31st, 1917 | Year Ending October 31st, 1918 | [illegible] |
|---|---|---|---|
| Power Introduced | 5.3 | 16.6 | 21.2 |
| Operating Costs | 11.6 | 10.2 | 8.1 |
| Maintenance | 6.1 | 5.4 | 2.7 |
| Overhead and General Expense | 2.4 | 4.2 | 2.7 |
| Interest, Discount and Insurance | 32.4 | 41.4 | 32.7 |
| Reserve Accounts | 16.4 | 14.8 | 26.2 |
| Totals | 100.0% | 100.0% | 100.0% |



## Analysis of Twenty Accounts.

### Generic Accounts.

The table below shows the annual and total costs for twenty the generic accounts on pages 20 to 24 and in Exhibits 7 and 72 of the report of Sanders, Trist, Underhill & Co. on the investigation of the methods of the Canadian Power Company, dated October 4th, 1917, Hydro-Electric Security Commission

file No. 175-a, and from the balance sheet and operating accounts for 1922 as recently submitted by Mr. Clarkson. The table is as follows:

Table of Reserve for Renewals

| Period | Reserve, less Charges |
|---|---|
| Adjusted Book Total to August 1st, 1917, | $ 880,833.35 |
| Year Ending October 31st, 1920, | 350,267.78 |
| Year Ending October 31st, 1921, | 267,506.23 |
| Year Ending October 31st, 1922, | 268,418.68 |
| Balance October 31st, 1922, | $ 1,767,026.04 |



It will be noted that the total at the credit of the fund was $1,498,607.36 at October 31st, 1921, in accordance with the Price, Waterhouse & Co. report, and the larger total for 1922 is with the addition of Mr. Clarkson's figures. It is understood that interest has not been added to the balance at the credit of this fund, as has been done on the other Systems, at a four per cent. rate.

The balance in the Reserve for Renewals Account was subdivided by Messrs. Price, Waterhouse & Co. as at October 31st, 1921, between the properties of The Ontario Power Company of Niagara Falls and its subsidiary, The Ontario Transmission Company, Limited, in the respective amounts of $1,125,363.59 and $373,243.77. There has been no similar subdivision made for 1922, but it would seem reasonable to divide the total in about the same proportion.

In the above table it will be noted that there was a credit balance of $880,833.35 in the account for renewals of plant and so forth as at August 1st, 1917, when the properties were acquired by the Hydro-Electric Power Commission of Ontario. This credit was made up largely of a transfer from the surplus

file No. 1764, and from the National Hydro and Power Commission statement for 1920 as recently submitted by Mr. Gibbons. The table is as follows:

Table of Reserve for Renewals

| Years. | Amounts. |
|---|---|
| Adjusted Book Value by August 1st, 1920. | $ [illegible] |
| Year Ending October 31st, 1920. | [illegible] |
| Year Ending October 31st, 1921. | [illegible] |
| Year Ending October 31st, 1922. | [illegible] |
| Balance October 31st, 1922. | [illegible] |
| | $ [illegible] |

It will be noted that [illegible] the result of the [illegible] $[illegible] at October 31st, 1922, is substantially the Price, Waterhouse & Co. report, and the Jackson Report for 1920 in view the existing of the discrepancy figures. It is unfortunate that interest has not been added in the balance as the amount of this would be more than offset by the depreciation at a fair per cent. rate.

The balance in the Reserve for Renewals account was subdivided by Price, Waterhouse & Co. as at October 31st, 1922, between the departments of The Ontario Power Company of Niagara Falls and the subsidiary, The Ontario Transmission Company, Limited, in the proportion amounts of $1,[illegible] and $[illegible]. These had been on similar subdivisions made for 1920, but it would seem reasonable to divide the total in about the same proportion.

In the above table it will be noted that there was a credit balance of $[illegible].00 in the account for renewals of plant and no charge as at August 1st, 1922, when the properties were purchased by the Ontario-Minnesota Power Company of Canada. This credit was made up mainly of a transfer from the surplus

account at that date as shown on pages 5 and 6 of the report of Messrs. Price, Waterhouse & Co. above referred to. There is no information available as to what actually constituted the credit amount in this fund at August 1st, 1917, and as the original books of account are not available, it has been impracticable to determine whether this reserve for renewals has been invested in plant or whether it represents intangible values or other investments.

It is stated that no appraisal of the properties has been made since the companies were acquired, but in order to determine rates to be used in the computation of the annual renewal provisions, the engineering department of the Commission made a reclassification of all the properties, exclusive of the extension known as the Third Pipe Line, Yil as shown on the books at July 1st, 1919. In the case of the third pipe line extension the analysis of the engineering department is stated to be based on book figures as at October 31st, 1919.



The rates established by this reclassification, and which are apparently being applied at present on a straight line basis, are as follows:

(1) 1.85% per annum on the properties, including lands, of The Ontario Power Company of Niagara Falls.

(2) 2.85% per annum on the third pipe line extension and hydraulic and other equipment used in connection therewith.

(3) 3.00% per annum on the properties, including right-of-way, of The Ontario Transmission Company, Limited.

No provision was made for renewals for the years ending October 31st, 1918, and October 31st, 1919, but in determining the amount of reserve for renewals for the fiscal years subsequent to 1919 it is understood that the above rates have been applied to the approximate balance of the property

account at the close of each year respectively, less certain deductions for intangible values.

On this basis the addition to the reserve in 1920 was $385,498.44, less charges for the year of $35,230.66, making a net addition of $350,267.78. In 1921 the amount set aside is stated to have been $385,814.69, less charges during the period amounting to $118,308.46, making a net total for the year of $267,506.23. In 1922 the net addition, after charges had been deducted, was apparently $268,418.68, as indicated by Mr. Clarkson's balance sheet.

In order to determine the adequacy of the reserve for renewals in respect to the combined properties at October 31st, 1922, it would be necessary to consider the following:



(1) The physical condition and value of the properties acquired at August 1st, 1917, and the extent to which intangible values such as rights, franchises, goodwill, were included in the purchase price, and the extent to which they are depreciable.

(2) The adequacy of the reserve for renewals at August 1st, 1917.

(3) The amount of provision which should have been made in respect of renewals for the period from August 1st, 1917, to October 31st, 1919.

(4) The adequacy of the provisions based on the present method of calculation for the years 1920, 1921 and 1922.

(5) The extent, if any, to which the factor of obsolescence may have been or requires to be given consideration.

(6) The future use of the plant in view of the fact that it may be decided to divert some or all of the water for use at a greater efficiency in the Queenston-Chippawa Development, in which case part or all of the plant

of The Ontario Power Company of Niagara Falls would be used as a stand-by or as a synchronous condenser station.

As some of the information outlined above is very difficult if not impossible to obtain, the adequacy of the renewals account presents a problem which may only be approximately solved. It is understood that it is the practice of the Hydro-Electric Power Commission to spend sufficient money on maintenance account each year to keep each and every portion of the System in a condition to operate in accordance with the requirements of economical production, which, it is stated, is considered to be about seventy-five per cent. as good as its original new condition. If this be so, the consideration of the renewals account might well be studied in connection with and applied to the renewal of only twenty-five per cent. of the depreciable capital concerned.



The balance sheet of the combined properties at October 31st, 1922, shows assets of approximately $31,000,000, which includes about nine or ten millions of dollars of intangibles. It is a question whether these intangible values should be considered as depreciating and subject to renewal account, and if so, to what extent. Considering all factors the amount of depreciable capital to be covered by a renewal account is probably of the order of six million or seven million dollars after making allowance for the portion provided for by maintenance account as above mentioned. As the plant has been in operation for nearly twenty years, it would appear that the total amount in the reserve account which now stands at approximately one and three-quarters millions of dollars on the books is smaller than it should be. Further, it should be borne in mind that no information is available regarding the composition of the initial provision for the fund and that the book value of the whole renewals account

apparently does not represent actual funds available for renewals or extensions, as the fund has been called upon for the retirement of bonds to the extent of over $700,000, and it is understood that these retired bonds form part of the renewals account as presently established on the books. The effect of this book-keeping adjustment is that if funds are required for renewals of plant it will be necessary to provide such funds by the resale of the retired bonds, or by issuing new bonds, or by some other means.

It has been stated by Messrs. Price, Waterhouse & Co. that the Hydro-Electric Power Commission has recently made further revisions in the renewal reserves and has applied certain amounts thereof to the contingency and sinking fund reserves, but the actual figures are not available and it is therefore impracticable to judge of the adequacy of the additions made to these funds or the effect on the renewal fund. It is difficult to understand what advantage is to be expected from a further reduction in the already inadequate reserve for renewals. It might be argued that the use of the reserve for renewals to provide a fund for the retirement of outstanding bonds could be justified if it is the intention to scrap the plant of the Ontario Power Company, but in that case it would seem reasonable that provision should be made to set aside a fund from revenues sufficient to pay all obligations before the plant will have lost its earning power.



Sinking Fund.

Sinking fund provisions are required and, as described below, some provisions have been made for the retirement of the following Bonds and

Debentures:

(1) First Mortgage Five Per Cent. Sinking Fund Gold Bonds of The Ontario Power Company of Niagara Falls, which are due February 1st, 1943. Of this issue the face value of the bonds outstanding at October 31st, 1921, was $9,218,000. The annual provision of $1.00 per horse-power, or approximately $150,000, is not sufficient to retire more than one-third of this amount in the remaining twenty-three years and some further provision might be considered for the financing of the difference before the bonds become due, or re-financing will have to be provided in 1943.

(2) First Mortgage Five Per Cent. Gold Bonds of The Ontario Transmission Company, Limited, which are due May 1st, 1945. The face value of the bonds of this issue outstanding at October 31st, 1921, was $1,630,000. The annual sinking fund provision of $30,000 payable on July 1st, is not sufficient to retire more than half this amount in the remaining twenty-four years.

(3) Four Per Cent. Forty-year Gold Debentures of The Hydro-Electric Power Commission of Ontario, guaranteed by the Province, were provided for the purchase of the capital stock of The Ontario Power Company of Niagara Falls and The Ontario Transmission Company, Limited. The full amount of this issue, namely $8,000,000, was outstanding at October 31st, 1921, and at that date the initial sinking fund provision of $100,000 was made out of revenue. This annual provision compounded at four per cent. interest will be sufficient to retire this issue in the remaining thirty-seven years of the life of the debentures.



(4) Six Per Cent. Twenty-year Bonds of The Hydro-Electric Power Commission of Ontario, guaranteed by the Province, were issued to retire the Six Per Cent. Gold Coupon Debentures of The Ontario Power Company of Niagara Falls, which fell due on July 1st, 1921, the authorized amount being $3,300,000, and of this $3,200,000 was issued and was outstanding at October 31st, 1921. The sinking fund provision of one per cent. of the par value of the bonds to be paid annually on June 1st, throughout the twenty-year life of the bonds, is only sufficient to retire the issue in about forty-one years, and some further provision might be considered to take care of the deficiency before the maturity of the bonds in 1941. The initial sinking fund provision of $11,309.59 for the period from July 1st to October 31st, 1921, was made from revenue at the latter date.

(5) Advances by the Commission to the Power Company for construction of the Third Pipe Line amounted to $3,515,094.93 at October 31st, 1921. In the year ending October 31st, 1921, an amount of $63,271.71 was set aside out of surplus as a first provision on account of sinking fund in connection with the cost of construction of the third pipe line and equipment. This is the annual provision required as a sinking fund with four per cent. interest to repay the cost of the pipe line in thirty years.

The sinking fund reserve for the year ending October 31st, 1921, was provided out of revenue for the following:

| | |
|---|---|
| On the $8,000,000 debenture issue of the Hydro-Electric Power Commission (initial provision) | $100,000.00 |
| On the cash advances for construction of the third pipe line extension (initial provision) | 63,271.71 |
| On the $3,200,000 bond issue of the Commission to retire the bonds of the Power Company due July 1st, 1921 - portion for period from July 1st, 1921, to October 31st, 1921, | 11,309.59 |
| | $174,581.30 |
| On First Mortgage Five Per Cent. Bonds of The Ontario Transmission Company, Limited, (four months' accrual - July 1st, 1921, to October 31st, 1921) | 10,005.46 |
| | $184,586.76 |



For 1922 Mr. Clarkson's operating account shows provision for sinking funds amounting to $100,000 on the $8,000,000 bonds of the Commission, $63,264.36 on cash advances for the third pipe line extension, and $32,000 on the $3,200,000 issue of the Commission due 1941. These three amounts total $195,264.36. There is apparently no direct provision for sinking fund on the first mortgage five per cent. bonds of The Ontario Transmission Company, Limited, but apparently $31,000 of this issue was retired from surplus at a cost of $30,000.

The sinking fund provisions in respect to the retirement of the first mortgage bonds of The Ontario Power Company of Niagara Falls and of The Ontario Transmission Company, Limited, apparently require that an annual sum of $1.00 per horse-power amounting to approximately $150,000 per annum be provided by the power company and that $30,000 be set aside annually by the transmission company.

The following table shows the deposits made for sinking fund purposes and deposited with the trustees since August 1st, 1917. The figures for the years 1918 to 1921, inclusive, are from the report of Messrs. Price, Waterhouse & Co., while the figures for 1922 have been deduced from the operating account submitted by Mr. Clarkson for that year. The table is as follows:

Amounts Deposited for the Retirement of Bonds

| Year | The Ontario Power Company of Niagara Falls | The Ontario Transmission Company, Limited |
|---|---|---|
| 1918 | $ 151,506 | $ 30,000 |
| 1919 | 147,441 | 30,000 |
| 1920 | 145,254 | 30,000 |
| 1921 | 165,054 | 30,000 |
| 1922 | 122,956 | 30,000 |



The above amounts have been used in the retirement of bonds, in every case somewhat larger in face value than the actual cash required for their retirement. The details of the bonds retired are given on page 27 and in Exhibit II-a of the report of Messrs. Price, Waterhouse & Co. up to the end of 1921. For 1922 Mr. Clarkson gives $126,000 as the First Mortgage Bonds of the Power Company, retired, and $31,000 as the amount of First Mortgage Bonds of the Transmission Company, retired.

In addition, the Second Mortgage Six Per Cent. Gold Debentures of the Power Company have all been retired, the details of which are also given in Exhibit II-a of the Price, Waterhouse & Co. report. The funds for the retirement of part of the bonds were apparently appropriated from surplus account, which was credited with the value of the retired bonds, when these were purchased and

The circumstances among the Ugandan men for showing that patients, not supported with the strongest claim, during 1914, 1917. The figures for the years 1916 to 1921 inclusive, are from the report of Harvey Bruce, Medicine 1 Ugandan the figures for last year have been obtained from the operating theatre records attend by Mr. Clarkson for that year. The table is as follows.

Patients Operated for the Amputation of Penis

| Year | The number Penis Amputated by Stages Skin | The total Treatment Value Ugandan, Labour |
|---|---|---|
| 1916 | 0 [illegible] | $ [illegible] |
| 1917 | [illegible] | [illegible] |
| 1918 | [illegible] | [illegible] |
| 1921 | [illegible] | [illegible] |
| 1922 | [illegible] | [illegible] |



The above amounts have been used in the calculation of bonus. In every case somewhat larger in size value than the actual work required for their original. The details of the work performed are given on page 27 and in Exhibit 1-4 of the report of Harvey Bruce, Kampala & Co. in the end of 1922. For 1922 Mr. Clarkson gives £12,000 as the first Kampala Bonus of the year company, retained, and £21,000 as the amount of first Kampala bonus of the transmission company, retained.

In addition, the famous Kampala Site for Tent, Still Shareholders of the Tanganyika have all been retained, the details of which are also given in Exhibit 1-4 of the Trade, Kampala & Co. report. The Bonus for the retirement of part of the bonus were separately accumulated from original account, while the creation with the value of the retained bonus, some there were transferred and

returned to the Companies' possession. The balance of the issue was retired by the new issue of the Commission's bonds in 1921.

A study of the operating accounts fails to show any direct provision from revenues for a fund, which might be called a sinking fund, to be used to retire bonds of the Ontario Power Company and of the Ontario Transmission Company, and it would appear upon analysis that the funds used in retiring the bonds have, to a large extent, been appropriated out of the reserve for renewals and that this renewal fund has in reality been depleted to the extent of about six hundred thousand dollars to the end of 1921, and about seven hundred and twenty-five thousand dollars to the end of 1922. The bonds retired apparently have been credited to the fund but do not represent available cash if renewals are required.



It would seem to be preferable to show the requirements for the retirement of the bonds of the Ontario Power Company and of the Ontario Transmission Company as a direct operating charge, as is done in the case of the sinking fund provisions to retire the bonds of the Hydro-Electric Power Commission and to pay the cash advances for the construction of the third pipe line extension.

An analysis of the sinking fund provisions now carried on the books will show that this is not sufficient for the retirement of the whole of the bonds by the various dates at which they fall due, the deficiency being of the order of one-half the whole requirement.

Contingencies Account.

A study of the accounts of the Ontario Power Company and the Ontario

Transmission Company, indicates that the reserve for contingencies has not been provided on the same basis as for the other systems where a charge of approximately twenty-five cents per year per horse-power sold is made, together with certain other provisions, but in this case it is apparently in the nature of a provision for outstanding claims or accrued liabilities. At October 31st, 1921, the amount at the credit of reserve for contingencies was $418,233.63 made up as follows:

| | |
|---|---|
| In respect to a claim against J. J. Albright, for sinking fund payments, | $87,575.83 |
| Claim against Niagara, Lockport and Ontario Power Company, | 29,413.05 |
| Reserve to cover claims of the Commissioners of the Queen Victoria Niagara Falls Park in respect to additional water rentals, | 275,000.00 |
| Charges against operations, in respect of claims for power supplied by the Toronto Power Company | 26,244.75 |
| Total | $418,233.63 |



For the following year ending October 31st, 1922, the reserve for contingencies is shown in Mr. Clarkson's balance sheet as $454,748.34.

If the Commission be obligated to pay the full amount of the claims listed in the above table, there will remain in the reserve for contingencies little or nothing to meet future contingencies of an unknown or catastrophic nature. While a second catastrophe such as the accident on April 20th, 1922, is not probable, the accident furnishes a striking proof of the advantages there would be in having a reserve fund for contingencies to cover accidents, although it might be considered unreasonable to have a contingent fund of

sufficient magnitude to cover the total costs of an accident which might wreck a large portion of the plant. It would therefore seem wise to provide for some contingent fund in addition to that now set up on the books.

## Discussion of Deficits and Surpluses

The accumulated surpluses as shown in the accounts for the five years ending October 31st, 1922, are as follows:

| At October 31st. | Accummlated Amount |
|---|---|
| 1918 | $ 7,380.54 |
| 1919 | 145,472.77 |
| 1920 | 103,320.08 |
| 1921 | 59,197.03 |
| 1922 | 53,947.82 |



The yearly surpluses or deficits and the accumulated surplus or deficit must be considered in connection with the reserve accounts. The amount of $53,947.82 shown as the accumulated surplus at October 31st, 1922, is not sufficient to materially affect the deficiency in the reserve accounts as discussed above.

## Revenues and Costs per Horse-power per Annum.

In order to reduce the total revenues and total costs of operation to a basis where these would be comparable with other systems and to agree with the usual practice of similar companies and of distribution authorities, a set of diagrams has been prepared to show the revenues per horse-power per annum from

different groups or classifications of consumers and to show the revenue per horse-power per annum for different bases of horse-power.

In a similar manner, the total costs have been reduced to costs per horse-power per annum for different bases of horse-power and have also been analyzed to show the total annual costs subdivided into fractional amounts chargeable against each kind of expense based on the horse-power rating of the plant, on the horse-power billed and on the average horse-power consumed. The following series of diagrams, with the table of figures for each, show these various items in detail.

The revenues per horse-power from the various classes of customers and the various revenues for each classification of horse-power are given in the tables below, and are shown diagrammatically on pages 52 and 53 hereof.

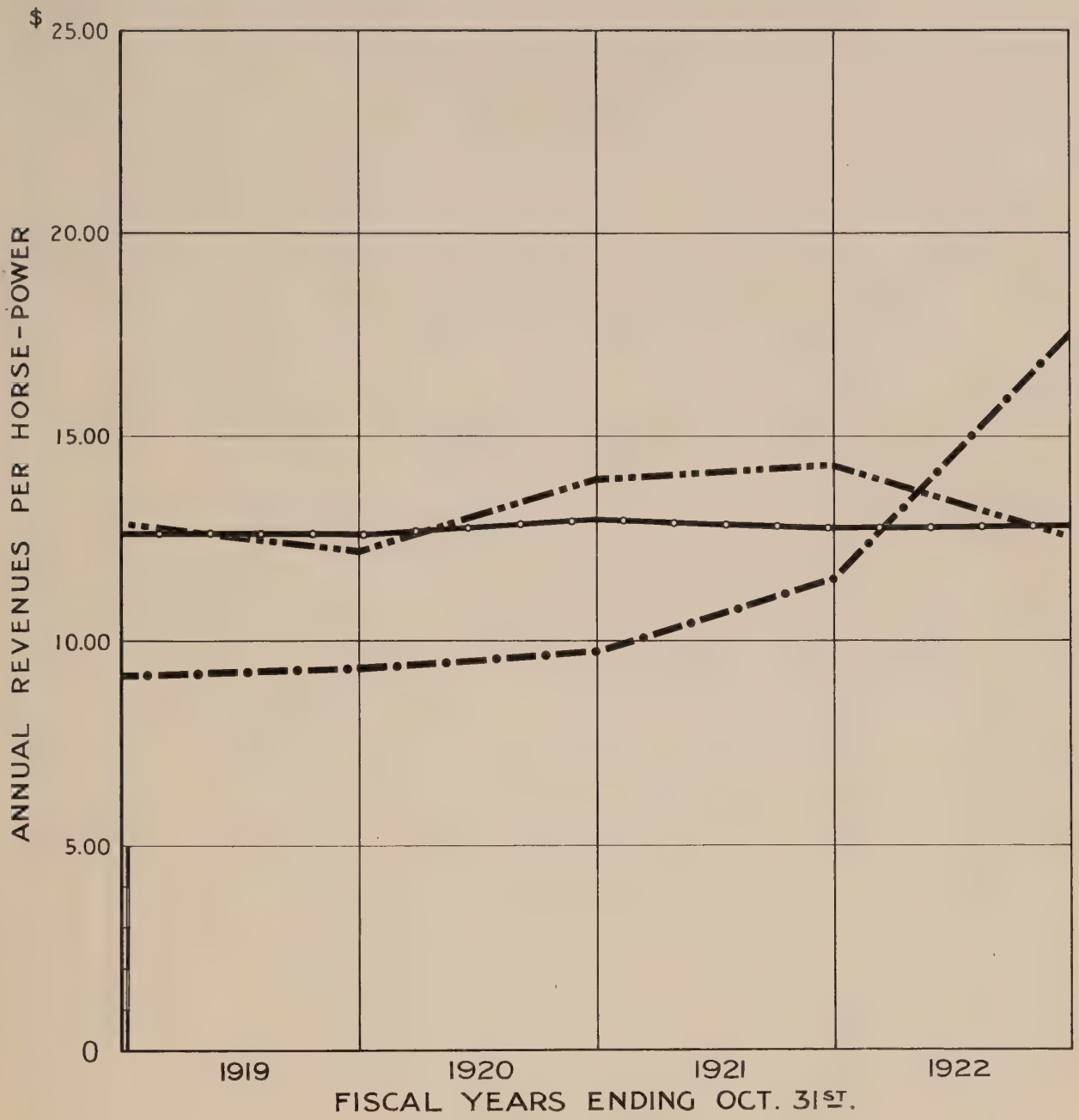


Table of Revenues per Horse-power for Various Classes of Customers

| | Fiscal Year Ending October 31st, 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Power Sold to H.E.P.C. | $ 9.15 | $ 9.36 | $ 9.72 | $11.55 | $17.55 |
| Power Sold to Private Companies | 12.82 | 12.25 | 13.97 | 14.33 | 12.57 |
| Power Sold for Export | 12.70 | 12.60 | 12.97 | 12.76 | 12.84 |

Table of Revenues per Horse-power per Annum

| | Fiscal Year Ending October 31st, 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Per H.P. Developed plus Purchased | $11.11 | $ 9.91 | $11.16 | $12.03 | $13.57 |
| Per H.P. Consumed | 12.48 | 14.23 | 14.41 | 17.20 | 21.58 |
| Per H.P. Billed | 11.00 | 10.88 | 11.35 | 12.30 | 15.17 |




Revenue Per H.P. Sold to H.E.P.C.

" " " " to Private Companies

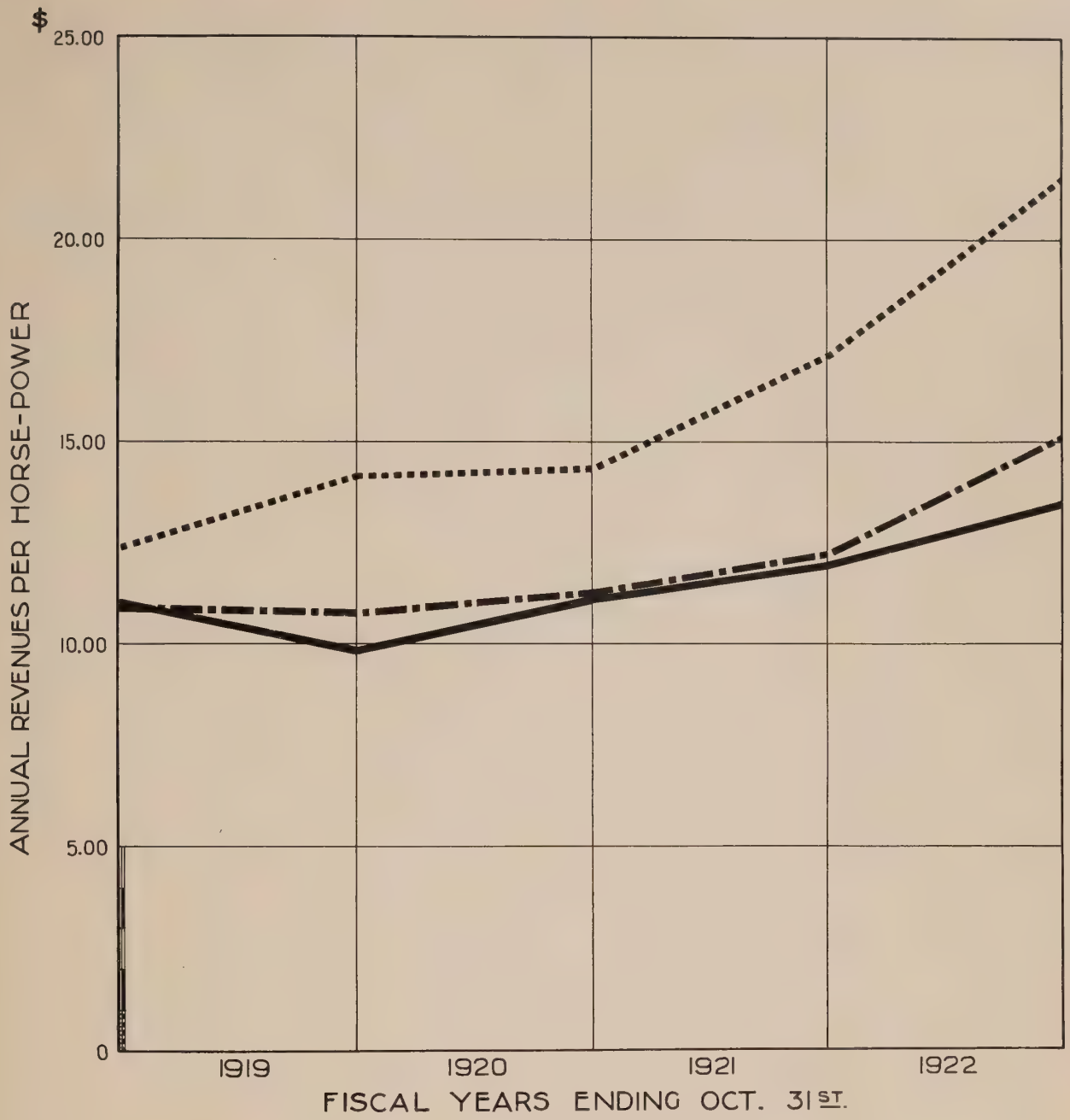
" " " " for Export

Hydro-Electric Inquiry Commission
W. D. Gregory, Chairman

Economics of H. E. P. C. Distribution Systems
The System of
THE ONTARIO POWER CO. OF NIAGARA FALLS

**REVENUES PER H.P. PER ANNUM**
**VARIOUS CLASSES OF CUSTOMERS**

Toronto, May 14th. 1923, Made by S.R.W., Checked by C.L.H.
Walter J. Francis & Company
Consulting Engineers




REVENUES PER H.P. DEVELOPED PLUS PURCHASED
" " " CONSUMED
" " " BILLED

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

THE SYSTEM OF

THE ONTARIO POWER CO. OF NIAGARA FALLS

**REVENUES PER H.P. PER ANNUM**

**VARIOUS H. P. BASES**

Toronto, May 14th., 1923. Made by [illegible] Checked by [illegible]

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Annual Costs per Horse-power.

The four sheets of curves on pages 56 to 59 and the tables on pages 55 and 60 show the details of the cost per horse-power per annum on different bases. The figures from which the curves were plotted are the figures for the operating costs given in the table on page 37 divided by the figures for the various classes of horse-power already given in the text. The sheet of curves included as page 56 indicates the total costs per horse-power per annum for the different classifications of horse-power already discussed. It will be noted that the total costs per horse-power in the various fiscal years do not balance with the total revenues per horse-power as a small surplus or deficit has been carried on the books in each of these years.



The sheet of curves on page 57 entitled "Subdivided Costs per Annum per Horse-power Developed plus Purchased" indicates the subdivision of the total annual costs as between power purchased, operating, maintenance, overhead and general expense, interest combined with discount on bonds and cost of American exchange, and additions to the reserve accounts, divided by the sum of the total amount of horse-power developed in the Ontario Power Company's plant and that purchased for the supply of its customers. Similarly the sheet of curves on page 58 indicates the subdivided costs per annum per average horse-power consumed by the various customers of the Ontario Power Company, and the sheet of curves on page 59 indicates the subdivided costs per annum per horse-power billed.

## Total Annual Costs per Horse-power

| | Fiscal Years Ending October 31st, 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Per H.P. Developed plus Purchased | $11.08 | $ 9.28 | $11.37 | $12.22 | $13.51 |
| Per H.P. Consumed | 12.46 | 13.35 | 14.69 | 17.46 | 21.47 |
| Per H.P. Billed | 10.99 | 10.21 | 11.58 | 12.48 | 15.10 |

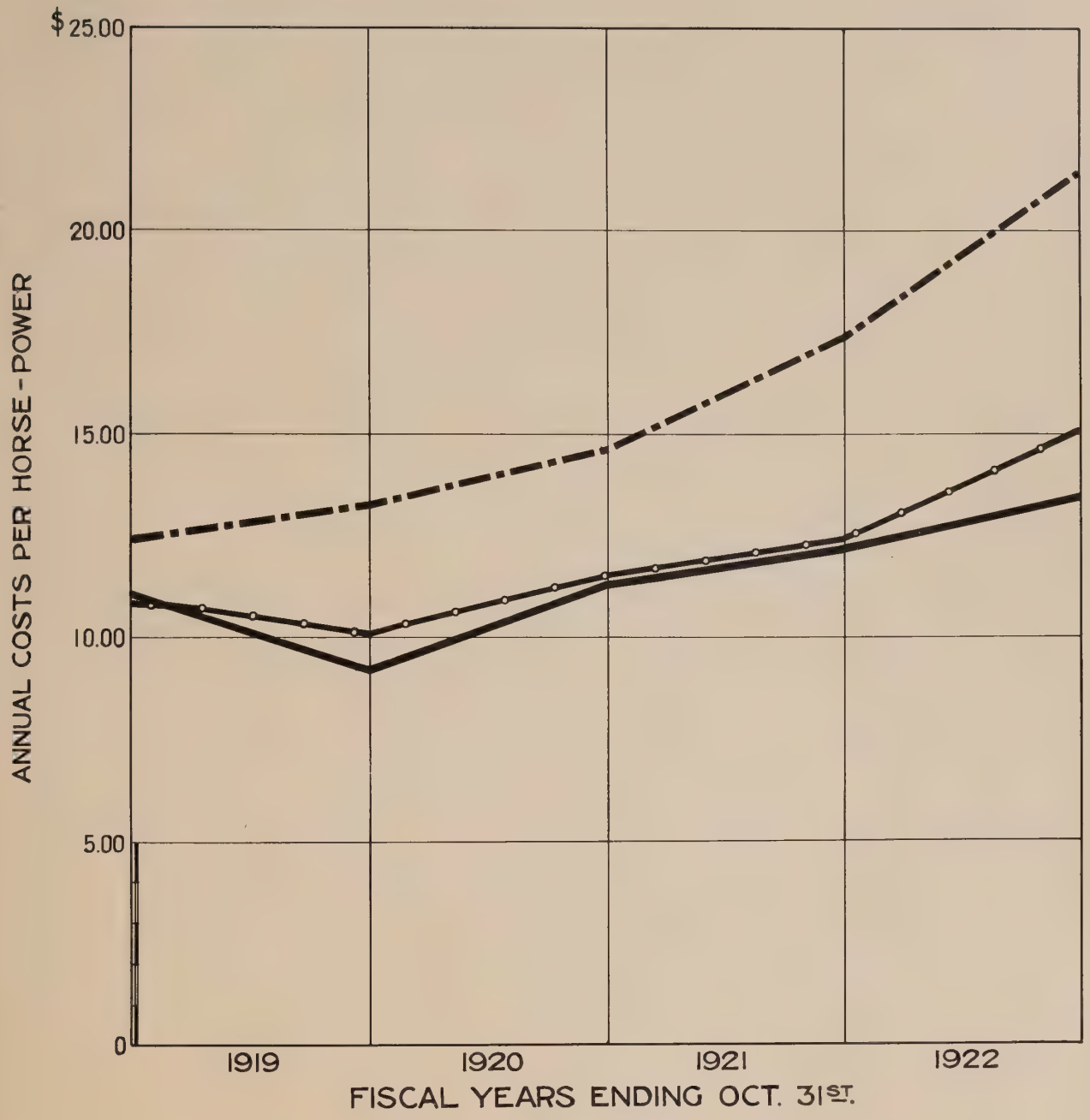
## Subdivided Costs per Horse-power Developed plus Purchased

| | Fiscal Years Ending October 31st, 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Power Purchased | $ 2.68 | $ 1.23 | $ .56 | $ 2.28 | $ 2.84 |
| Operating Costs | 1.08 | 1.21 | 1.32 | 1.24 | 1.29 |
| Maintenance | .31 | .53 | .71 | .66 | .80 |
| Overhead and General Expense | .77 | .81 | .72 | .56 | .52 |
| Interest, Discount and Exchange | 5.63 | 5.15 | 5.32 | 6.04 | 5.59 |
| Reserve Accounts | .56 | .35 | 1.74 | 1.44 | 2.37 |
| Totals | $11.08 | $ 9.28 | $11.37 | $12.22 | $13.51 |



## Subdivided Costs per Horse-power Consumed

| | Fiscal Years Ending October 31st, 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Power Purchased | $ 3.01 | $ 1.77 | $ .72 | $ 3.26 | $ 4.52 |
| Operating Costs | 1.21 | 1.74 | 1.71 | 1.77 | 2.06 |
| Maintenance | .40 | .77 | .91 | .94 | 1.26 |
| Overhead and General Expense | .87 | 1.16 | .93 | .80 | .98 |
| Interest, Discount and Exchange | 6.34 | 7.40 | 8.17 | 8.63 | 8.88 |
| Reserve Accounts | .63 | .51 | 2.25 | 2.06 | 3.77 |
| Totals | $12.46 | $13.35 | $14.69 | $17.46 | $21.47 |




Cost Per H.P. Developed Plus Purchased
" " " Consumed
" " " Billed

Hydro-Electric Inquiry Commission
W. D. Gregory, Chairman

Economics of H. E. P. C. Distribution Systems

The System of

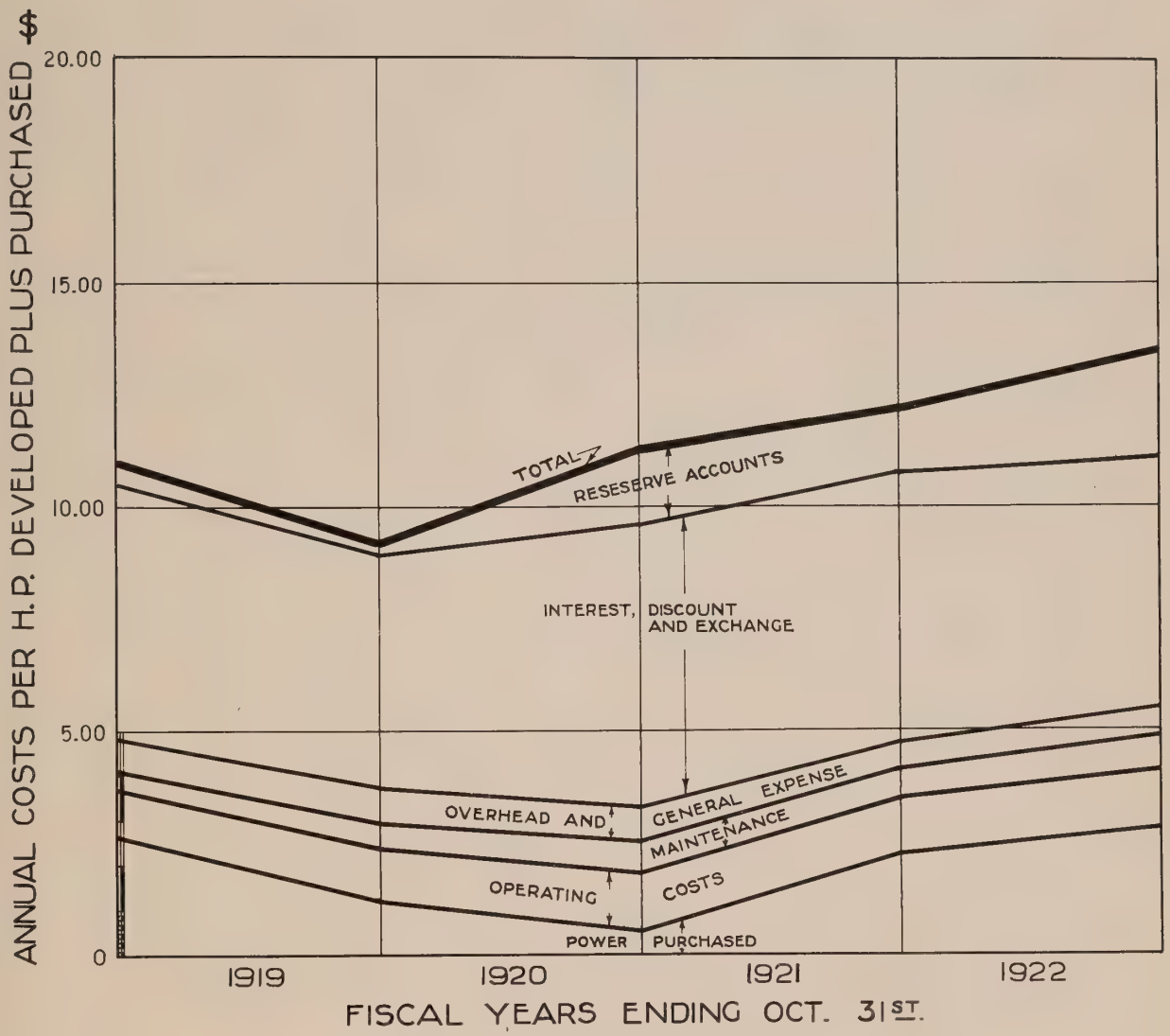
THE ONTARIO POWER CO. OF NIAGARA FALLS

**TOTAL COSTS PER H.P. PER ANNUM**

**VARIOUS H.P. BASES**

Toronto, May 14th., 1923. Made by GEO., Checked by LDV.

Walter J. Francis & Company
Consulting Engineers




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

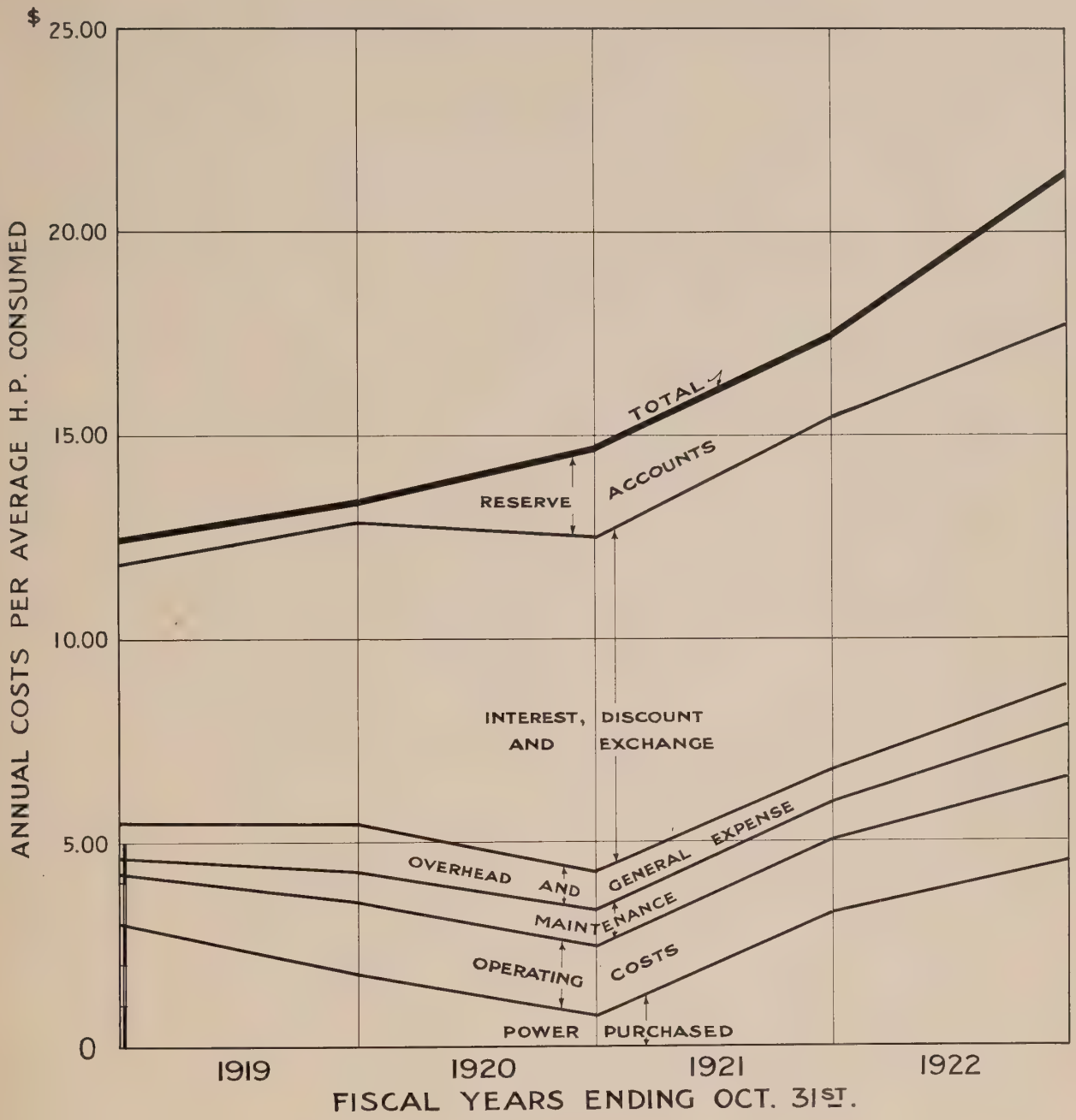
THE SYSTEM OF

THE ONTARIO POWER CO. OF NIAGARA FALLS

**SUBDIVIDED COSTS PER ANNUM PER H.P. DEVELOPED PLUS PURCHASED**

Toronto, May 14th., 1923. Made by C.E.D., Checked by C.L.H.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

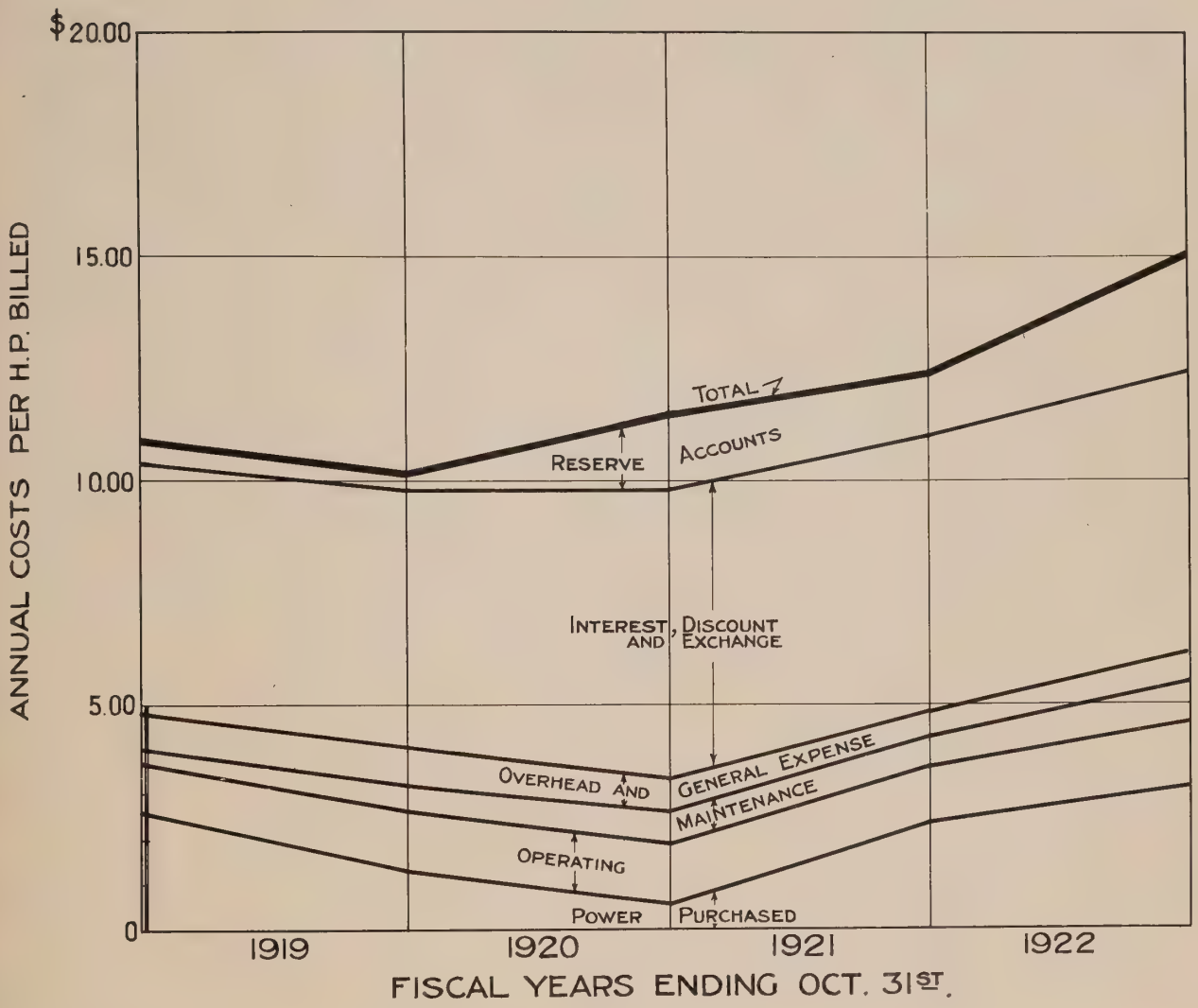
THE SYSTEM OF

THE ONTARIO POWER CO. OF NIAGARA FALLS

**SUBDIVIDED COSTS PER ANNUM PER H.P. CONSUMED**

Toronto, May 14th. 1923, Made by S.R.W., Checked by L.J.H.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

THE SYSTEM OF

THE ONTARIO POWER CO. OF NIAGARA FALLS

**SUBDIVIDED COSTS PER ANNUM PER H.P. BILLED**

Toronto, May 14th., 1923. Made by G.E.B., Checked by L.H.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Subdivided Costs per Horse-power Billed

| | Fiscal Years Ending October 31st, 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Power Purchased | $ 2.65 | $ 1.35 | $ .57 | $ 2.33 | $ 3.17 |
| Operating Costs | 1.07 | 1.33 | 1.35 | 1.27 | 1.45 |
| Maintenance | .35 | .59 | .72 | .67 | .89 |
| Overhead and General Expense | .77 | .89 | .73 | .57 | .69 |
| Interest, Discount and Exchange | 5.58 | 5.66 | 6.44 | 6.17 | 6.25 |
| Reserve Accounts | .56 | .39 | 1.77 | 1.47 | 2.55 |
| Totals | $10.99 | $10.21 | $11.58 | $12.48 | $15.10 |

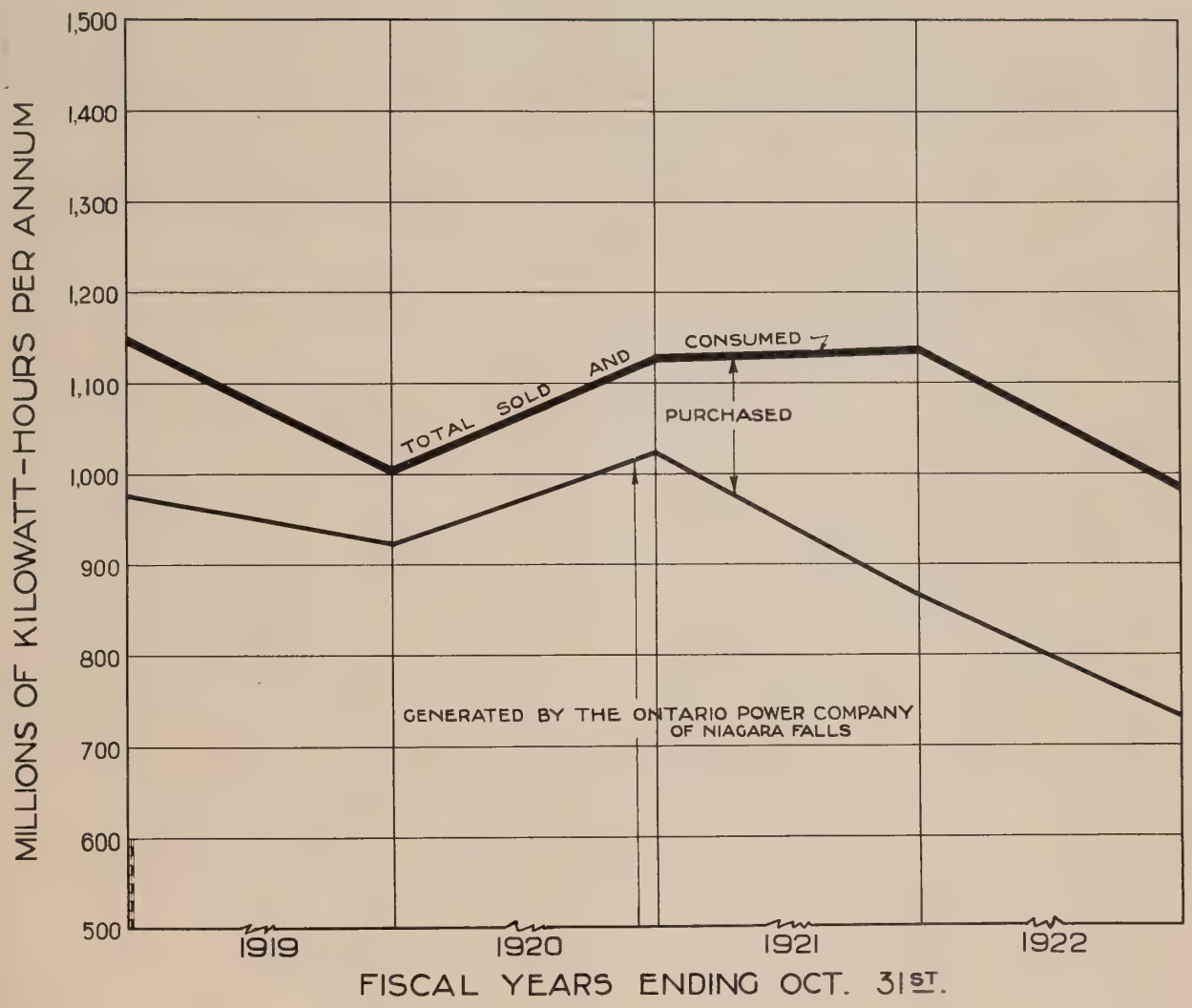
Kilowatt-hour Data and Annual Revenues and Costs per Kilowatt-hour.



The table below and the sheet of curves included as page 61 show the kilowatt-hours generated and purchased and the total kilowatt-hours sold by the Ontario Power Company for the fiscal years 1918 to 1922, inclusive. This energy was measured at the Ontario Power Company's generating station and includes losses in the transmission lines, and the figures have been corrected to include power delivered by the Toronto Power Company directly to Electro-Metals, Limited.

Table of Kilowatt-hours Generated, Purchased and Consumed

| | Fiscal Years Ending October 31st, 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Millions of kilowatt-hours | | | | | |
| Generated by the Ontario Power Company | 978.9 | 928.4 | 1,026.2 | 869.8 | 731.6 |
| Purchased | 172.6 | 83.6 | 105.0 | 271.2 | 258.4 |
| Sold and Consumed | 1,151.5 | 1,009.0 | 1,131.2 | 1,141.0 | 990.0 |




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
THE SYSTEM OF
THE ONTARIO POWER CO. OF NIAGARA FALLS

# KILOWATT-HOUR DATA

Toronto, May 14th., 1923. Made by [illegible], Checked by [illegible]

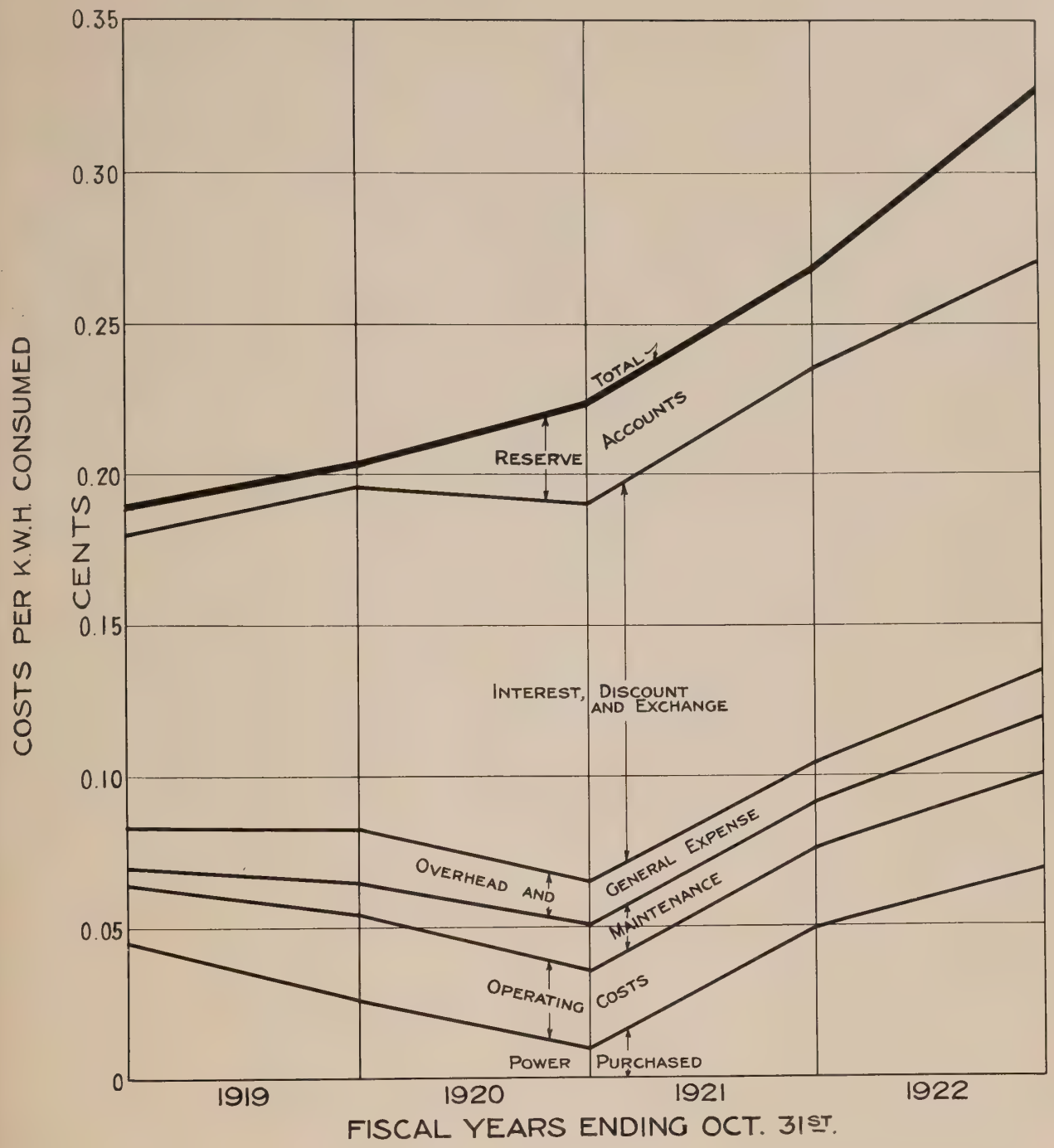
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

These figures were obtained directly or deduced from information furnished by the engineers of the Hydro-Electric Power Commission.

The following table and the sheet of curves on page 63 show the total cost per kilowatt-hour sold and consumed, including purchased power, subdivided in the usual way. The total revenues per kilowatt-hour have been included in the table for comparison. They differ from the costs due to the small operating surplus or deficit shown on the books in the various years.

Subdivided Costs per Kilowatt-hour Consumed, in Cents

| | Fiscal Years Ending October 31st, | | | | |
|---|---|---|---|---|---|
| | 1918 | 1919 | 1920 | 1921 | 1922 |
| Power Purchased | .0461 | .0271 | .0111 | .0499 | .0690 |
| Operating Costs | .0186 | .0266 | .0262 | .0272 | .0314 |
| Maintenance | .0062 | .0118 | .0140 | .0144 | .0193 |
| Overhead and General Expense | .0133 | .0178 | .0142 | .0122 | .0150 |
| Interest, Discount and Exchange | .0971 | .1133 | .1253 | .1323 | .1357 |
| Reserve Accounts | .0097 | .0078 | .0344 | .0316 | .0575 |
| Total Costs per K.W.H. | .1910 | .2044 | .2252 | .2676 | .3279 |
| Total Revenues per K.W.H. | .1911 | .2178 | .2210 | .2633 | .3300 |




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
THE SYSTEM OF
THE ONTARIO POWER CO. OF NIAGARA FALLS

**SUBDIVIDED COSTS PER K.W.H. CONSUMED**

Toronto, May 14th., 1923. Made by G.E.B. Checked by L.D.H.
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

A Study of the Economic Effect of the Accident on April 20th, 1922, at the Plant of The Ontario Power Company of Niagara Falls.

In accordance with the recent instructions of the Hydro-Electric Inquiry Commission, conveyed through Mr. J. H. G. Bower, Secretary, and having regard to data available up to June 7th, 1923, a study has been made of the economic effect of the accident at the plant of The Ontario Power Company of Niagara Falls, which occurred on April 20th, 1922, and which resulted in the demolition of the roof of the northerly part of the plant, the total destruction of Generator No. 15 and very serious damage to Generator No. 16, with considerable injury to the auxiliary plant connected with these two machines, and the temporary disablement of four other large generators through water damage.



A detailed report of the accident was made to the Hydro-Electric Inquiry Commission by Mr. Walter J. Francis under date of November 18th, 1922, and may be referred to for any details desired in connection therewith.

The object of the present study is to determine the limits of the economic effect of the accident. As a result of this study the various cases outlined below show the economic effects, and they may be stated briefly as follows:

Case No. 1 - Assume the damaged plant to be replaced with the minimum amount of machinery which would produce the same output as before the accident.

Case No. 2 - Assume the damaged plant to be replaced by one unit of somewhat larger capacity than one of the destroyed units, to make the plant of the same capacity as before.

A Study of the Economic Effects of Pollution on Fish Life, from the Point of the Water Conservation Engineer.

In accordance with the general instructions of the Conservation Engineering Committee, arranged through Dr. J. D. L. Harris, Director, and Darrel Evans by data available up to June 6th, 1955, a study has been made of the economic effect of the pollution of the waters of the Ontario Power Company of Niagara Falls, which empties on Niagara River, and which enters in the condition of the river at the principal point at the plant, the total Conservation of Energy Dr. It was very evident a change in Conservation Dr. It, with consequent injury to the fishing industry somewhat with lower the condition, and the industry diminished at the Niagara Falls Commission fishing value dropped.

A detailed report of the problem was made to the Conservation Commission by Dr. Dalton J. Pratt in Under date of November 15th, 1955, and may be referred to for any details treated in connection therewith.

The object of the present study is to determine the limits of the economic effect of the condition. In a result of this study the various money fishing value show the economic effects, and they may be shown briefly as follows:

Case No. 1 - Assume the fishing plant is to be replaced with the maximum amount of equipment which would yield the same return as before the pollution.

Case No. 2 - Assume the fishing plant is to be replaced by the full of some lower quality than one of the replaced equipment, to take the place of the lost equipment.

Case No. 3 - Assume the damaged plant to be replaced by two units of identical capacity with those destroyed.

Case No. 4 - Assume that neither of the damaged units would be replaced and that the third pipe line would be adapted to serve the remaining fourteen units, amortising the cost of the unproductive portion of the third pipe line extension during its estimated useful life of thirty years.

Case No. 1.

Assuming the damaged plant to be replaced with the minimum amount of machinery which would produce the same output as before the accident, the capacity may be placed at approximately 200,000 horse-power with everything in perfect operating condition and with all the units running at full capacity, but with no spare capacity nor spare units. Under ordinary operating conditions the maximum output of the plant is shown by the records to have been between 190,000 and 195,000 horse-power. After the accident, with the three pipe lines feeding the remaining fourteen generating units, the maximum output obtained was about 175,000 horse-power. With fourteen machines operating and with only the two larger pipe lines feeding them, the maximum output of the plant is stated to have been about 160,000 horse-power, or about 150,000 horse-power under ordinary operating conditions.

In order to develop the maximum output of the plant with three pipe lines it would therefore be necessary to replace the two units, Nos. 15 and 16, by one or two units of sufficient capacity to raise the output from approximately

175,000 horse-power as at present existing to approximately 200,000 horse-power under maximum conditions, and to a figure between 190,000 and 195,000 horse-power under ordinary operating conditions.

It is understood that arrangements have been concluded by the Hydro-Electric Power Commission of Ontario whereby one 15,000 K.V.A. generating unit will be replaced by using good parts out of the two damaged machines, Nos. 15 and 16, together with spare parts and such other new parts as are necessary. This reconstituted unit will be ready in the autumn of 1923, probably in the month of October. The total cost to the Commission of the complete new unit so prepared is estimated not to exceed $15,000.00.



It is stated by the engineers of the Hydro-Electric Power Commission that the cost of the building repairs, and of the minor repairs to the other four units damaged in the accident, is between $30,000 and $40,000. The engineers further state that part of the cost of repairing Turbine No. 15 is fairly chargeable against ordinary repairs and not specifically against the accident, for the reason that no repairs of consequence had been made during the time Units Nos. 15 and 16 were in operation, or during about three years. It is also stated that part of the cost of repairing the building is directly chargeable against other items apart from the accident because the space occupied by Unit No. 16 is being prepared for use as the machine shop of the plant. Repairs continue to be done in a small temporary wooden building at the northerly end of the power house and near the water's edge, and it is stated that the Park Commissioners now demand its removal.

The engineers of the Hydro-Electric Power Commission state that the total output of the plant thus remodelled will be practically the same as before the accident, and that they expect to obtain a regular output of 145,000 kilowatts, equivalent to about 193,000 electrical horse-power, from the fifteen units, being practically the same figure as was obtained under ordinary operating conditions with the sixteen units as formerly arranged. At the extreme, they say that the difference between the maximum peak output as before the accident and after the remodelling will be only a very few thousand horse-power, and that this is negligible when considered from an efficient operating point of view.



As a matter of interest it may be noted that the engineers further say that Mr. Jackson, of the Queen Victoria Niagara Falls Park Commission, has recently made certain requests with regard to the removal of the third pipe line, or, alternatively, its being made a permanent structure by concreting that portion of it which is not now so protected and covering it with earth and grading the fill to conform to the surrounding surface of the Park. The estimated cost of removing the third pipe line is about the same as the estimated cost of concreting the structure and doing the necessary backfilling and grading; but in any case this cost is not chargeable to the accident. It is the expressed intention of the engineers of the Hydro-Electric Power Commission to make the third pipe line permanent by following this course.

Assuming that the above procedure will place the plant in practically the same condition as before the accident, from the viewpoint of operating, the

cost of the accident may be considered as about $50,000.00, being the cost to the Hydro-Electric Power Commission of the reconstituted Unit No. 15, together with building repairs and minor repairs to other main units, but exclusive of machine shop accommodation and ordinary machine repair allowance.

Assuming that the annual cost of power to customers is being adjusted to include all the fixed charges on the third pipe line extension, they are not accumulating as a charge against the Company, and the total cost of the accident would be placed at less than $50,000. This, however, is not a true economic measure of the loss, because the fixed charges are chargeable against the accident for at least the length of time it would have taken to replace the damaged plant, and possibly for the actual length of time between the accident and the date of completion of the replacement plant. The latter is open to objection if there were undue delay in commencing replacement because it would be improper to bill the fixed charges for a longer period than reasonably required to replace the damaged plant.



If it had been possible immediately after the accident to decide in detail as to the replacing of the destroyed units, the replacement might have been accomplished in six months under the most favourable circumstances. Making due allowance for contingencies it could doubtless have been done in less than nine months. In addition to the costs of the actual repairs, it might therefore be considered that interest and sinking fund on that portion of the third pipe line extension cost which was not producing output would have to be carried for a period of eight months.

It is estimated by Mr. Guilfoyle, of Messrs. Clarkson, Gordon & Dilworth,

so improper to bill the final charges for a larger period than necessarily required to replace the damaged plant.

If it has been profitable initially, after the emergency is over, it would be so to the replacing of the destroyed units. The requirements might have been accomplished if the Canadian Air Force had experienced crashes. While the allowance for contingencies it would doubtless have been done in late than this position. In addition to the usual [illegible] it would be necessary that reserves and [illegible] time extension over which one not producing engine should have to be carried for a period of eight months.

Included in the liability, at Sentry Camp, there is [illegible].

in a letter to the secretary of the Hydro-Electric Inquiry Commission under date of February 13th, 1923, that the annual interest and sinking fund on an investment of $3,515,000, representing the cost of the third pipe line extension, amounts to $196,717.77 for interest, and $63,271.71 for sinking fund, or a total of $259,989.48. With the output of the third pipe line extension before the accident estimated at 40,000 horse-power and after the accident at 15,000 horse-power, it would seem reasonable to allow twenty-five - fortieths, or five-eighths, of the annual interest and sinking fund charges for a period of eight months as the capital charges due to the accident. This figure is about $108,000, which might be added to the estimated repair costs of $50,000 already given above, making a total of about $158,000 as the cost of the accident, if the replacement work had been commenced immediately following the catastrophe.



Based on the actual procedure which is being followed, namely the replacement of Units Nos. 15 and 16 by a single unit installed in 1923, it might be considered that fixed charges on the cost of the unproductive portion of the third pipe line extension should be charged against the accident until the new unit is actually ready. If this argument be sound, the sum of about $135,000, being interest and sinking fund on twenty-five - fortieths of the annual charges for ten months of 1923, should be added, making the total cost $293,000 if the unit is ready by October 31st, 1923.

In addition to the cost of installing machinery and repairing the building and plant so as to restore the whole to its former capacity, and in addition to the cost of interest and sinking fund on the unproductive portion of the cost of the third pipe line extension, it might be considered necessary to take into

account the net cost of supplying power to customers during the repair period.

The Ontario Power Company of Niagara Falls being a separate legal entity which was presumably obligated to supply power under contract to its various consumers, it might be argued that it should have purchased power to the extent of the deficiency during the repair period in order to supply its customers under their contracts. It is stated by the engineers of the Hydro-Electric Power Commission of Ontario that the interpretation of the various contracts concerned is that the accident of April 20th, 1922, should be considered of such a nature as to relieve the Company of the necessity of purchasing power to supply their customers during the repair period. Good arguments may be brought forward in support of this contention, and it is doubtful if the Company could have been compelled to supply power under the conditions which obtained subsequent to the accident. If, however, the Company were obligated to supply its customers, even at the expense of purchase instead of generation, the difference between cost price and selling price would be the only figures affecting the estimated cost of the accident. It appears that the cost of purchased power in 1922 would be about $15.00 or $16.00 per horse-power per annum, and that the revenues per horse-power billed averaged about the same amount, so that the purchase of power to supply customers affected by the accident would represent practically neither profit nor loss.



In addition to the main item of 25,000 horse-power lost through the accident, it might also have been necessary under this interpretation to purchase sufficient power to provide for the lost output from the four machines which suffered minor damage from water for a period varying from a few days to a few

weeks, but it is not likely that this amount of power would represent any serious cost under the ordinary power contract conditions, provided that due diligence was shown in repairing the damaged machines, which was actually the case.

It seems unnecessary to go further into this phase of the subject or to allow anything for additional costs of the accident due to any portion of the output being lost. In any event, it is not likely that this item would represent an economic loss of any serious amount. It is therefore considered herein that purchased power need not be considered as affecting the result.

The records show that the loss of profits on the average to the whole plant would be practically negligible if the Company did not have to supply power to the affected customers under its contract.



There are several methods whereby the cost of this accident may be provided for in the operating accounts. One method is to charge the whole replacement cost against repairs for the year 1922, and add the total amount to the cost of power for that year. The second method is to spread the amount over several years; while a third method is to add the total cost to the capital investment, and amortise it over the ordinary life of the plant, say, thirty years. By the first method, if the figure of $150,000 be accepted as the total cost of the accident, and charged entirely to 1922, it would mean an additional charge between 75 cents and $1.00 per horse-power for the output of the plant during that year. Similarly, if the total cost be spread over three or five years, these additional annual power costs would be one-third or one-fifth of the

above figures.

If the total cost of the accident be added to the capital cost and amortised in thirty years, the total annual cost would be represented by interest and sinking fund charges on the amount determined as the cost of the accident. For example, if $158,000 be the cost, the total interest and sinking fund charges might be placed between 7 per cent. and 8 per cent., or a figure in the neighborhood of $12,000 per annum. Based on the maximum output of the plant, this represents about 6 cents or 7 cents per horse-power per annum.

Case No. 2.



Assuming the damaged plant to be replaced by one unit of somewhat larger capacity than one of the destroyed units, to make the plant of the same capacity as before, we have a condition practically the same as Case No. 1 with the substitution of, possibly, a 20,000 K.V.A. generating unit for the 15,000 K.V.A. generating unit actually being replaced. Assuming the same arrangements as those outlined in Case No. 1, a sum between $100,000 and $150,000 would probably be sufficient to pay for the difference in the capacity of the unit, and should be added to the various costs given in Case No. 1 for purposes of comparison.

Case No. 3.

Assuming the damaged plant to be replaced by two units of capacity identical with those destroyed, as indicated in the beginning of the report of Mr. Walter J. Francis, under date of November 18th, 1922, the output would not be

double of that obtainable from one unit because of the limiting hydraulic conditions in the pipe lines, but, as it would be restoring the condition of the plant prior to the accident, it may be useful for purposes of comparison.

It is estimated that to replace both of the damaged units would have required expenditures of the order of $350,000, to which should be added building repairs of $30,000 or $40,000, together with about $108,000 of carrying charges during the reconstruction period of eight months. This would make the total cost of the accident of the order of half a million dollars, as mentioned in Mr. Francis's report.

If this particular restoration had not been decided upon until some time after the accident, and assuming that it would be completed in October, 1923, the sum of $135,000 might be added as the carrying charges on the unproductive capacity in a similar way to that outlined in Case No. 1.



Assuming that the total prompt replacement cost of the accident be added to capital and amortised in thirty years, the annual charges for interest and sinking fund when divided by the total output of the plant represent an addition to the cost of power of about 16 cents per horse-power per annum, while if the fixed charges be carried for ten additional months in 1923 and added to capital and amortised in the same way, the annual difference in the cost of power would be about 24 cents per horse-power per annum.

Case No. 4.

Assuming that neither of the damaged units would be replaced and that the

third pipe line would be adapted to serve the remaining fourteen units, amortising the cost of the unproductive portion of the third pipe line extension during its estimated useful life of thirty years, the cost of the accident would amount to very large figures, as it would represent about twenty-five - fortieths of the total annual fixed charges on the third pipe line extension, or about $162,000 per annum, equivalent to about 80 cents per horse-power per annum. The total amount payable over the thirty years would be approximately $4,875,000. It seems unnecessary to consider this case, as it is evidently the intention of the Hydro-Electric Power Commission to replace the damaged plant with sufficient machinery to restore approximately the former output.



Conclusion as to Economic Effect.

From the above outline it will appear that the estimated cost of the accident is determinate within certain limits only, depending upon the viewpoint taken. It seems reasonable to assume that the limits of cost are between $50,000 and $650,000. Based on the actual procedure now being followed, and assuming that the new unit will practically restore the former output of the plant, and charging the whole of the carrying charges on the unproductive capital against the accident up to the time of the replacement of the damaged plant, it would be fair to place the total cost of the accident at about $300,000 in round figures.

## Summary.

A summary of a number of the more salient points which have been studied and discussed in the foregoing report may be of advantage in concluding the consideration of the economics of the System of The Ontario Power Company of Niagara Falls.

(1) The total capital costs per horse-power developed appear at first sight to be higher than would naturally be expected in a large development so advantageously situated as the Ontario Power Company, but this is in great measure due to the large item for intangibles. It is very difficult to determine the constitution of the various tangible and intangible values without access to the original books and records of the Company.

(2) The increase in capacity due to the Third Pipe Line Extension was obtained at a high cost and unfortunately a large part of the increase in capacity was lost due to the accident on April 20th, 1922. This resulted in a considerable increase in the capital costs per horse-power available at the end of 1922. With the replacement of one of these units in 1923, a decrease in the capital costs per horse-power will result.

(3) It might be considered advisable to separate the properties of The Ontario Transmission Company from those of The Ontario Power Company of Niagara Falls by retiring the bonds of the Transmission Company, and incorporate the transmission system in the Niagara System, and also to have the power purchase from other Companies at Niagara Falls supplied directly to the Hydro-Electric Power Commission and not pass through the Ontario Power Company as at present. If this were done it would be possible to determine exactly the status of the Ontario Power Company as a generating plant.

(4) The reserves for sinking funds to retire the bonds of the Ontario Power Company and the Ontario Transmission Company might be included as a direct operating cost and consideration should be given to increasing them to such an extent that they will provide for the retirement of the full face value of the bonds at the dates at which the various issues become due. Similarly the reserve for sinking fund to retire the bonds of the Hydro-Electric Power Commission due in 1941 might be increased to an amount sufficient to provide for the retirement of that issue when due.

(5) The reserve for renewals might be studied with a view to providing an adequate amount from revenue and not used as a bond retirement fund as

apparently is now being done.

(6) A reserve for contingencies might well be provided as an insurance against accidents and unforeseen conditions.

Walter J. Francis
Consulting Engineer.

Toronto, June 7th, 1923.

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APPENDIX

Contracts for Power Purchased by The Ontario Power Company of Niagara Falls.

I-(a) Contracts between the Ontario Power Company and the Toronto Power Company.

| | Date | Duration | Amount | Rate per H.P. per Year |
|---|---|---|---|---|
| (1) | Sept. 5th,1914 | 3 years | 20,000 K.V.A. | $13.00 for 75 per cent. of rated capacity of the two units and 2 mills per K.W.H. for the balance. |
| (2) | Oct. 18th,1915 | 5 years | 10,000 K.V.A. | $13.00 for 75 per cent. of rated capacity and from $12.40 to $30.00 for balance. |
| (3) | Mar. 17th,1916 | 1½ years | 10,000 K.V.A. | $13.00 for entire output of unit. |



Under the orders of the Power Controller, Sir Henry Drayton, this last block of power (item 3) was delivered by the Toronto Power Company until March 1st, 1920. Under date of April 20th, 1918, the Toronto Power Company was ordered to deliver to the Ontario Power Company, 11,000 horse-power with the assistance of the steam plant of the Toronto Electric Light Company, and this was continued until December 31st, 1918. This order also provided for an additional amount of 5,000 horse-power for the use of the American Cyanamid Company which was delivered from September 28th to November 9th, 1918. The amount paid to the Toronto Power Company for 18,200 horse-power plus 11,000 horse-power delivered under the Power Controller's orders for the entire period was $510,000.00. This amount was agreed upon by the two parties after an action had been commenced in the Exchequer Court. From November 14th, 1920, the

surplus capacity of the Toronto Power Company was purchased by the Ontario Power Company at a price of $15.00 per horse-power per annum, which was fixed by Brig.-Gen. C. H. Mitchell under his award dated July 28th, 1921. From November 14th, 1920, to October 13th, 1921, approximately 17,000 horse-power was purchased, 15,000 horse-power of which was delivered to the Ontario Power Company's plant and 2,000 horse-power to some of the Ontario Power Company's customers at Welland. From October 13th, 1921, the output of another unit of 15,000 horse-power was purchased under the same terms and supplied when ordered.

I-(b) Contracts between the Canadian Niagara Power Company and the Niagara Falls Power Company and the Hydro-electric Power Commission for the Account of the Ontario Power Company, for Power from the Canadian Niagara Power Company Plant.



| Date of Letters | Duration | Amount | Rate per H.P. per Year |
|---|---|---|---|
| From Company Dec.18th,1919<br>To Company Dec.19th,1919 | 2 years from Jan. 1st, 1920 or until Chippawa Development is ready | 9,000 H.P. | $18.00 per H.P. per year for output of machine. Discontinued January 31st, 1922. |
| From Company Nov.26th,1920<br>To Company Dec. 8th,1920<br>From Company April 22nd,1922<br>To Company April 24th,1922 | 6 months from Dec. 1st,1920 | 9,000 H.P. | $16.20 per H.P. per year for output of machine, payable in U.S. funds. Discontinued Jan. 31st, 1922 and picked up April 20th. Discontinued May 31st, 1922. |
| From Company Nov.12th,1921<br>To Company Dec.10th,1921<br>From Company April 22nd,1922<br>To Company April 22nd,1922 | From Nov.13th, 1921 until Chippawa Development is ready | 10,723 H.P. | $16.20 per H.P. per year for output of machine, payable in U.S. funds. Discontinued Jan.31st, 1922,and picked up April 20th, 1922. Discontinued May 31st, 1922. |

(Appendix-c)

I-(b), Continued:

| Date of Letters | Duration | Amount | Rate per H.P. per Year |
|---|---|---|---|
| From Company Nov.23rd,1921<br>To Company Nov.29th,1921<br>From Company April 22nd,1922<br>To Company April 24th,1922 | From Nov.23rd, 1921, until Chippawa Development is ready | 10,723 H.P. | $16.20 per H.P. per year for output of machine, payable in U.S. funds. This power was delivered by the Niagara Falls Power Company to the Niagara, Lockport and Ontario Power Company who released a corresponding amount in the delivery by the Ontario Power Company. Discontinued February 28th,1922, and picked up April 20th, together with an additional 10,000 H.P. Discontinued May 31st, 1922. |

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I-(c) Contract between the Ontario Power Company and the Niagara, Lockport and Ontario Power Company for Steam Power.

| Date of Letters | Duration | Amount | Rate |
|---|---|---|---|
| From Company Dec. 6th,1921<br>To Company Dec. 15th,1921 | Indefinite | 10,000 K.W. | $300.00 for a two hour period and $90.00 for each additional hour. In consideration of the above the Lockport Company agreed to release 10,000 K.W. of the contract between them and the Ontario Power Company dated December 30th,1913. |

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

(Appendix-d)

II. Contract between the Ontario Power Company and the Niagara, Lockport and Ontario Power Company.

| Date | Duration | Amount | Rate |
|---|---|---|---|
| July 16th,1904 Dec. 30th,1913 | Until April 1st, 1950 | 45,000 K.W. | $16.76 per K.W. per year for 40,000 K.W. and 2-1/2 mills per K.W.H. for any excess above 40,000 K.W. |

Under date of April 12th, 1917, Mr. J. J. Albright gave personal undertaking that he would cause the Lockport and Ontario Power Company to release 10,000 H.P. of the Ontario Power Company obligation to them until October 13th, 1920. This was compensation in part for the expiry and non-renewal of the contracts between the Ontario Power Company and the Toronto Power Company.

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III. Contract between the Hydro-Electric Power Commission and the Toronto Power Company.

| Date | Duration | Amount | Rate |
|---|---|---|---|
| Oct. 29th,1915 | 6 months to April 30th, 1916 | 12,000 H.P. | $13.00 |

IV. Contract between the Ontario Power Company and the Hydro-Electric Power Commission.

| Date | Duration | Amount | Rate per H.P. per Year |
|---|---|---|---|
| Feb. 3rd,1909 | March 18th, 1930 | 100,000 H.P. | $9.00 |
| March 21st,1914 | March 18th, 1930 | 1,000 H.P. | $14.00 for St. Catharines and included as part of 100,000 H.P. |

IV. Continued:

| Date | Duration | Amount | Rate per H.P. per Year |
|---|---|---|---|
| May 27th, 1913 | March 18th, 1930 | 100 plus H. P. | $14.00 for Port Robinson and included as part of 100,000 H.P. |
| Feb.26th, 1913 | March 18th, | 300 H. P. | $14.00 for Welland. The power was supplied from Niagara High Tension Station at 46,000 volts on September 16th, 1917. |

V. Contract between the Hydro-Electric Power Commission and the Canadian Niagara Power Company. (Not billed through the Ontario Power Company).

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In 1915, about 13,200 H.P. was delivered at the direction of the Federal Government, following a conference attended by representatives of the Federal and Provincial Governments, the Canadian Niagara Power Company and the Hydro-Electric Power Commission. Under this arrangement, the amount of power was increased, until at the end of 1916 about 50,000 H.P. was being delivered. The rate, pending the execution of an agreement, was fixed at $12.00.

A contract was executed on December 30th, 1922, for the output of two units, or a total of 20,000 H.P., at a rate of $15.00 per H.P. per year. This contract expires on May 1st, 1930.

VI. Contract between the Ontario Power Company and Electro-Metals, Limited.

A two-year contract for 11,000 horse-power was executed on February 1st.

1920, at a rate of $7.25 per horse-power per year. This amount is the difference between the rate paid by Electro-Metals, Limited, to the Ontario Power Company under contract dated April 6th, 1907, and that paid to the Toronto Power Company under contract dated February 1st, 1920. The Toronto Power Company supplied the Ontario Power Company contract from February 1st, 1920, to March 16th, 1922.

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